

VECTORS AND DISEASE

WHY DOES THE VECTOR MATTER?



Mosquitoes



Ticks



Sand flies



Fleas



Chigger Mites



Lice



Tsetses

COL Jennifer Caci

US Army Special Operations Command

**Why
does the
vector
matter?**



**It's not just
about
disease...**



OUTLINE

- Threats
 - What does “vector-borne” mean?
 - Understanding vector-borne disease epidemiology
 - Area specific, risk assessment
- Resources
 - Where can you get information?
- Identifying Important Vectors
- Prevention
 - What can you do to minimize risk?

What is a vector?

- An arthropod that becomes infected with a pathogen and is able to transmit it to another host
- Although an arthropod is able to maintain a parasite alive within its body, transmission depends upon its competence as a vector

What are the priority threats?

It always depends but, in general according to “the experts”...



REPLY TO
ATTENTION OF

MCHE-MDI

DEPARTMENT OF THE ARMY
BROOKE ARMY MEDICAL CENTER
3851 ROGER BROOKE DRIVE
FORT SAM HOUSTON TX 78234-6200

23 April 2010

MEMORANDUM FOR RECORD

SUBJECT: Infectious Disease Threats to the US Military Prioritization Panel Results

1. A panel was hosted by the Directorate of Combat and Doctrine Development (DCDD) and the Military Infectious Diseases Research Program (MIDRP), US Army Medical Research and Materiel Command (MRMC), under the umbrella of the Medical Force Protection Integrated Capabilities Development Team (ICDT) Charter to prioritize the current infectious disease threats to the US Military (Appendix A).
2. Panel objectives were to identify and operationally prioritize the infectious disease threats to US Forces to assist in the determination of capability requirements.
3. References included "Initial Capabilities Document (ICD) for Infectious Disease Countermeasures (IDCM)," 2006, and "Infectious Diseases Investment Decision Evaluation Algorithm: A Quantitative Algorithm for Prioritization of Naturally Occurring Infectious Disease Threats to the U.S. Military," *Military Medicine* 2008;173:174-181.

Appendix A

Prioritization of Infectious Disease Threats to the US Military

1.	Malaria
2.	Dengue
3.	Diarrhea, bacterial
4.	Multidrug-resistant (MDR) wound pathogens
5.	Leishmaniasis
6.	Q fever (<i>Coxiella burnetii</i>)
7.	Norovirus and other viral diarrhea
8.	Influenza
9.	Adenovirus
10.	Leptospirosis
11.	Diarrhea, protozoal
12.	Tuberculosis (TB)
13.	Crimean-Congo hemorrhagic fever
14.	Human immunodeficiency virus (HIV/AIDS)
15.	Hemorrhagic fever with renal syndrome (HFRS)
16.	Chikungunya
17.	Meningococcal meningitis
18.	Plague
19.	Rickettsioses
20.	Viral encephalitides
21.	Hepatitis E
22.	Lassa fever and other arenaviruses
23.	Tick-borne encephalitis
24.	Rift Valley fever
25.	Hepatitis C
26.	Brucellosis
27.	Other arboviral illnesses
28.	Typhoid fever
29.	Cholera
30.	Schistosomiasis
31.	Tularemia
32.	Trypanosomiasis
33.	Ebola/Marburg hemorrhagic fever
34.	Chagas' disease
35.	Yellow fever
36.	Lyme
37.	Bartonellosis (Oroya fever)
38.	Soil-transmitted helminths

PRIORITY THREATS

1. Malaria

2. Dengue

4. Leishmaniasis

13. CCHF

16. Chikungunya

18. Plague

19. Rickettsioses

20. Viral enceph

23. TBE

24. Rift Valley fever

**27. Other
arboviruses**

Vectorborne Disease Threats

TABLE 1. Past and present impact of vector-borne diseases of military importance among deployed troops

	Past threats	Present threats	Other diseases of less importance
Sandfly-borne diseases	Sandfly fever Old World cutaneous leishmaniasis New World mucocutaneous leishmaniasis Visceral leishmaniasis	★ Sandfly fever ★ Old World cutaneous leishmaniasis ★ New World mucocutaneous leishmaniasis ★ Visceral leishmaniasis	Oroya fever
Mosquito-borne diseases	Malaria Lymphatic filariasis Yellow fever Japanese B encephalitis Dengue fever Chikungunya disease	★ Malaria ★ Dengue fever ★ Chikungunya disease Rift Valley fever virus ★ West Nile virus	O'nyong nyong virus, Semliki Forest virus, Sindbi virus, and other mosquito-borne viruses
Flea-borne diseases	Plague Murine typhus	Plague? Murine typhus?	Flea-borne spotted fever
Louse-borne diseases	Typhus Trench fever Louse-borne relapsing fever		
Tick-borne diseases	Rocky mountain spotted fever Mediterranean spotted fever African tick bite fever Other common tick-borne spotted fevers Ehrlichiosis Q-fever* Tularemia* Crimean–Congo hemorrhagic fever Tick-borne encephalitis	★ Rocky mountain spotted fever Mediterranean spotted fever African tick bite fever ★ Other common tick-borne spotted fevers Ehrlichiosis ★ Q-fever* Tularemia* ★ Crimean–Congo hemorrhagic fever	New pathogenic rickettsiae (<i>Rickettsia slovaca</i> , <i>Rickettsia helvetica</i> , and <i>Rickettsia sibirica mongolitimonae</i>) 'Rickettsia of unknown pathogenicity' Colorado tick fever Kemerovo tick fever Other tick-borne fevers (Dugbe or Banjha virus) Omsk hemorrhagic fever Kyasanur Forest disease Alkhurma virus hemorrhagic fever Human babesiosis
Mite-borne diseases	Scrub typhus	Scrub typhus	
Tsetse fly-borne diseases	Sleeping sickness	Sleeping sickness	
Kissing bug-borne diseases	Chagas disease	★ Chagas disease	

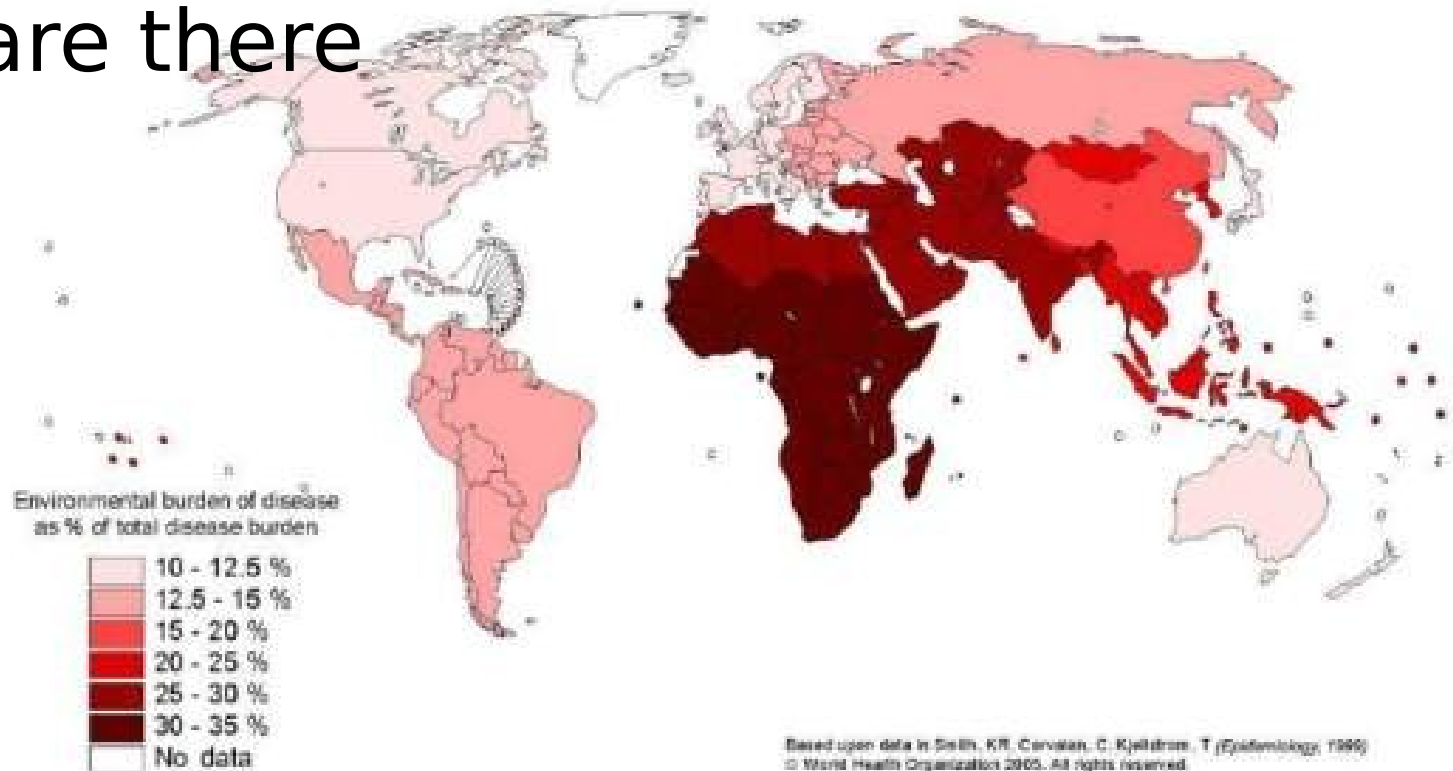
* the main risk for forces is not the vector-borne transmission

Pages et al., 2010. The past and present threat of vector-borne diseases in deployed

RISK

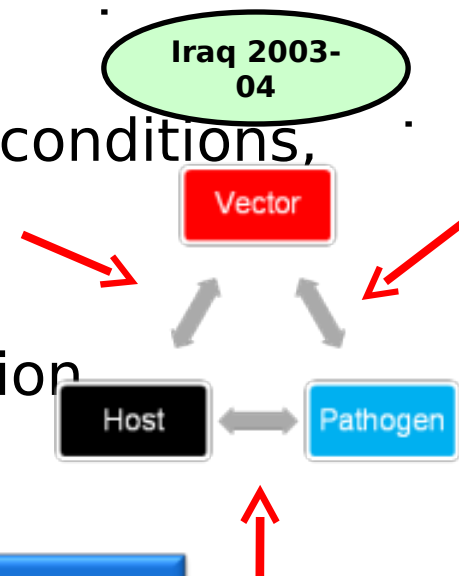
What are the threats in my AO?

Depends on **where** you are and **when** you are there



Components of Transmission

- ❑ **Pathogen**
 - Imported genotypes, mutations, replication rate
- ❑ **Vector**
 - Feeding behavior, host preference, habitat, vector competence, density, life span
- ❑ **Host and reservoir populations**
 - Susceptibility, immunity, density, living conditions, movement
- ❑ **Landscape**
 - Climate, rainfall, temp, humidity, elevation habitat



Where can you break the cycle?

Factors for Estimating Risk

1. What pathogens and strains/species are present?

(*P. falciparum* is far more serious than *P. vivax*)

2. Will the mission put personnel into close contact with vectors?

- VECTOR BEHAVIOR
 - *Anopheles* mosquitoes are nighttime biters.
 - *Aedes* mosquitoes are daytime biters.
 - Sandflies typically fly close to the ground.
- VECTOR HABITAT...Will personnel operate in areas with vectors?
- BILLETING...in buildings with doors and screened windows?

3. Will conditions support disease transmission?

- SEASONALITY
- RECENT WEATHER (rain and mosquitoes, wind and sand flies)
- DENSITY OF VECTOR
- INFECTION RATE

4. What is the Incubation Period?

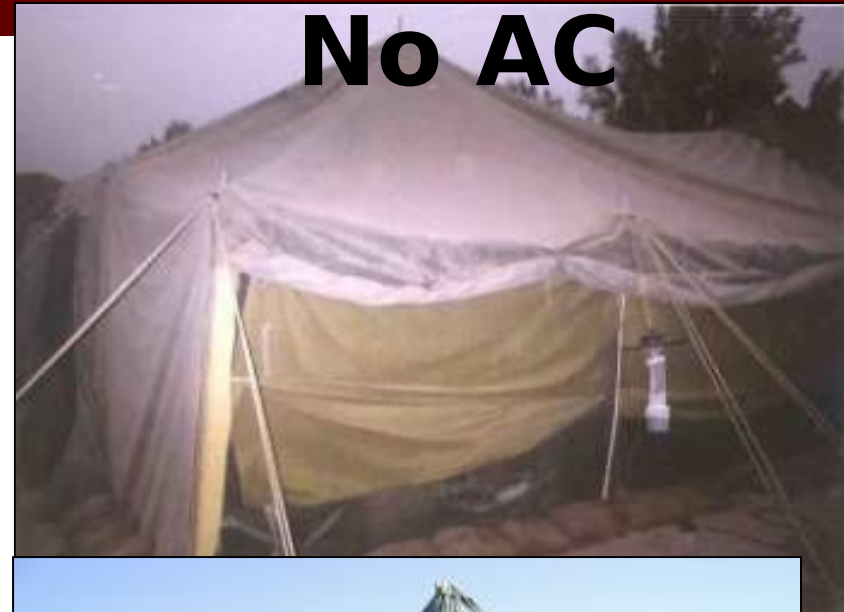
- IMMEDIATE VS. DELAYED IMPACT



Air Force Tent City



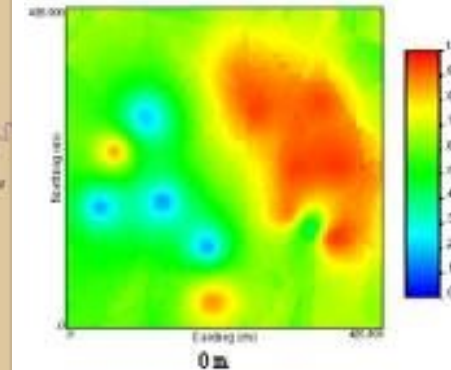
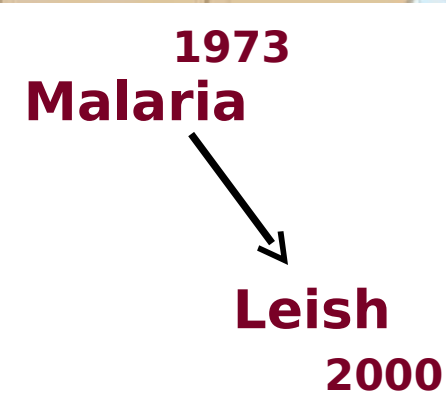
Army Tent City



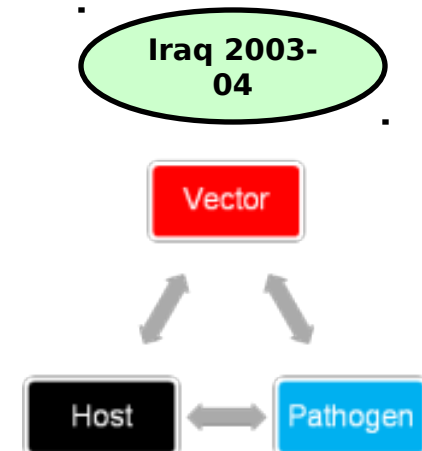
Examples
of varied
risk levels
in austere
environments



Example

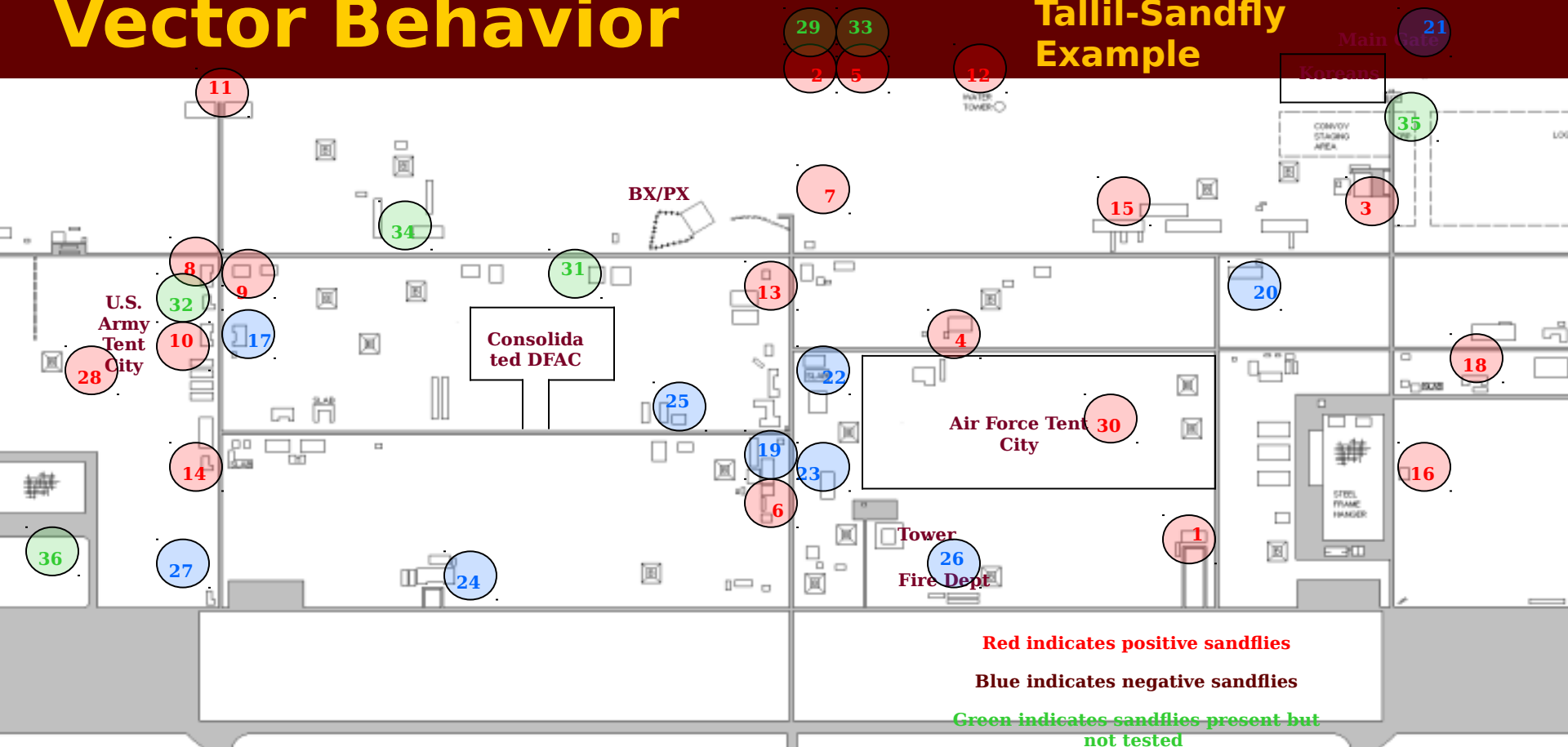


Land cover and Temperature



Vector Behavior

Tallil-Sandfly Example



Location	collected	tested	infected	Location	collected	tested	infected	Location	collected	tested	infected	Location	collected	tested	infected
1. AF-407 th AEG TOC	510	131	2.29%	10. Mosque	131	89	1.12%	19. 486 th CA Bn	108	52	0.00%	28. Army Tent City	3,691	303	1.98%
2. Control Site 3	2,803	612	0.65%	11. 2220 th Trans	4,088	2,064	1.31%	20. V Corps IG	55	44	0.00%	29. Control Site 1	1,087		
3. 1/293 rd INF, HHD	30	21	4.76%	12. 1208 th QM Co	16,280	3,128	0.90%	21. Airbase Entrance	53	28	0.00%	30. AF - Tent City	2,353	845	2.37%
4. AF - Post Office	351	74	4.05%	13. Army Finance	3,217	478	0.21%	22. Laundry/Bath	20	18	0.00%	31. AF - 407 th Maint	612		
5. Control Site 4	5,104	803	1.49%	14. 933 rd MP Co HQ	749	115	1.74%	23. 63 rd Sig Bde	14	11	0.00%	32. S of 221 st MI Bn	454		
6. 171 st ASG	1,180			15. 744 th MP Bn	674	74		24. 86 th CSH	10	5		33. Control Site 2	318		
												34. AF-Security Force	268		
												35. Convoy Center	230		



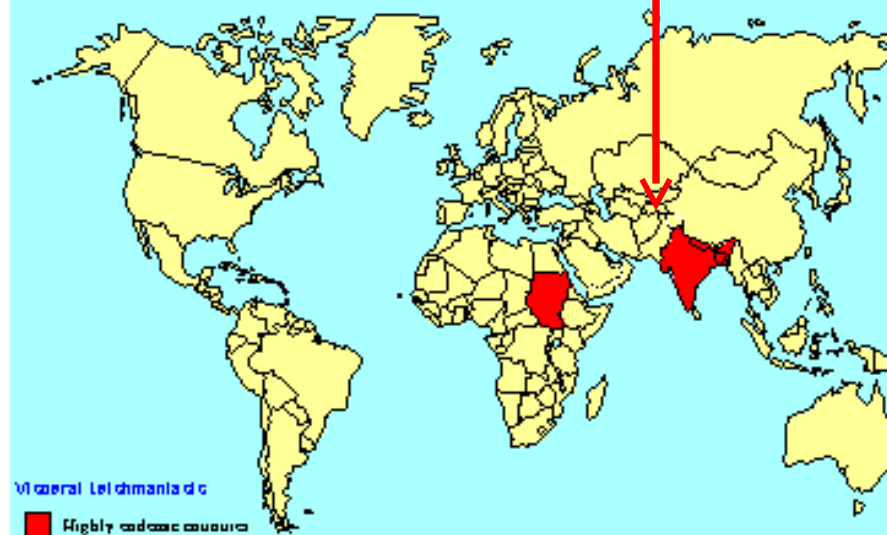
- Model of *P. falciparum*
- No transmission in areas surrounded by high transmission
- Why?
- No vectors; the cycle was broken with appropriate pesticide use



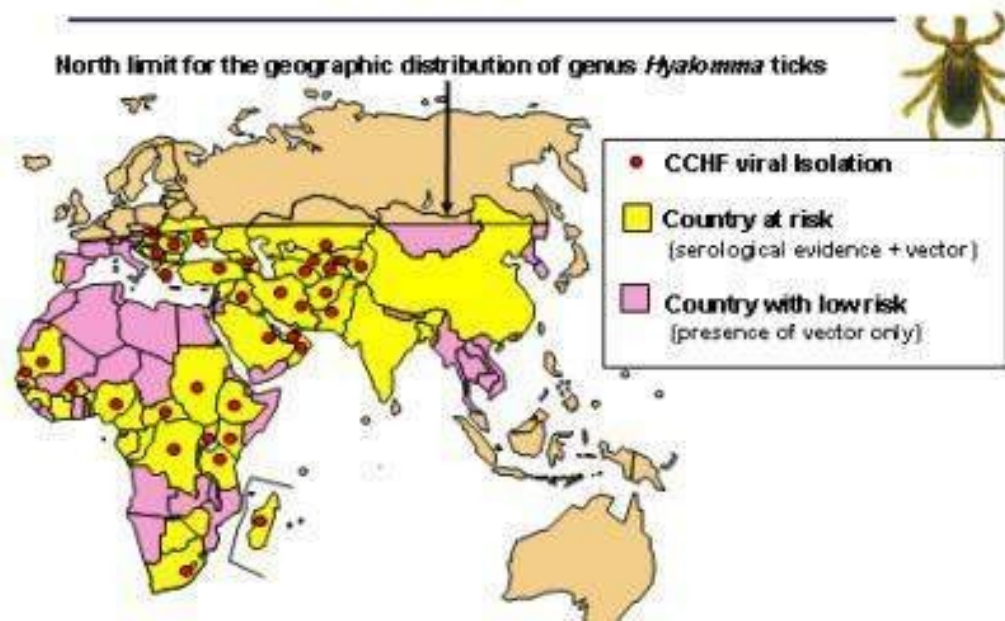
Cutaneous Leishmaniasis
Highly Endemic Countries (90% of cases)



Visceral Leishmaniasis
Highly Endemic Countries (90% of cases)



CCHF: geographic distribution



Is there effective control or is no one is looking?

HELP IN IDENTIFYING PRIORITY THREATS

- **Entomological Operational Risk Assessments (EORA)**
 - Provide risk estimates for vector-borne and zoonotic diseases in the country of concern.
 - These estimates, prepared by USAPHC.
 - EORAs available for >30 countries.
- **Infectious Disease Risk Assessment (IDRA)**
 - AFMIC now NCMI
 - Web-based and CD (MEDIC)
 - Classified and unclassified medical intelligence/information
- **Disease Vector Ecology Profiles (DVEP)**
 - <http://www.afpmb.org/content/disease-vector-ecology-profiles>
 - **Geosentinel**
 - **ProMed**

RESOURCES

Where can you find answers?

- Regional Public Health Command (PHC), Ento Div
<http://chppm-www.apgea.army.mil/ento/default.htm>
- AFPMB
<http://www.afpmb.org>
- NCMI (MEDIC CD)
- WRAIR Ento Div
- Walter Reed Biosystematics Unit (WRBU)
<http://wrbu.si.edu> and
<http://mosquitomap.nhm.ku.edu/vectormap/>
- Command PM assets

http://www.
afpmb.org



Armed Forces Pest Management Board

recommends policy, provides guidance, and coordinates the exchange of information on all matters related to DoD pest management

[Log in/Register](#)

Search AFPMB.org

[Search the AFPMB Website](#)

Questions?

[Send a question to the Board](#)

DoD Topics

- [Pesticide & Equipment Lists](#)
- [Training & Certification](#)
- [DoD Pesticide Hotline](#)

Literature



Hosted Sites



Military Entomology



Army

Navy

Air Force

Board Meeting Info

Next Board Meeting:
Oct. 31 - Nov 4, 2011

- [Information from last meeting](#)
- [Board Minutes & Staff Reports](#)
- [Committee Workspaces](#)



AFPMB Directorate Staff, April 2011

Contingency & Deployment Resources

We provide support to DoD personnel on any pest management issue in any situation. We also provide rapid accurate responses to questions regarding all aspects of pest management and maintain the website to meet the needs of our customers. [Find a resource now](#)

Literature Retrieval System

Our Literature Retrieval System is an online collection of scientific papers comprising over 100,000 documents in searchable PDF format, drawn from our extensive library of books, journals, reprints, reports, and other sources. [Search our database of over 120,000 PDFs](#)

Deployed War-Fighter Protection (DWFP) Program

The Deployed War-Fighter Protection research program (DWFP) is an initiative to develop and validate novel methods to protect United States Military deployed abroad from threats posed by disease-carrying insects. [Read more](#)

Disease Vector Ecology Profiles

Disease Vector Ecology Profiles (DVEPs) summarize unclassified literature on medically important arthropods, vertebrates and plants that may adversely affect troops in specific countries or regions of the world. [Read more](#)

Technical Guides

As a unit of the AFPMB, ISD (Information Services Division) collects, stores and disseminates published and unpublished information on arthropod vectors and pests, natural resources, and environmental biology important to the DoD. [Read more](#)

Living Hazards Database

The Living Hazards Database (LHD) is a comprehensive compilation of more than 500 species worldwide, which are reported to cause serious injury or death of humans. [Read more](#)

What's New

- [Audrey Perich and Brian Zechner receive award for development of lethal avtrap](#)
- [Report of the 5th Annual Meeting of the Roll Back Malaria Partnership](#)
- [Roll Back Malaria Progress & Impact Series](#)
- [Archives](#)

Flickr Images



[Go to our image database](#)

YouTube Videos



[More](#)

Follow Us:



REGIONAL RISK

DVEPS

- Provide risk estimates for vector-borne and zoonotic diseases in the regions of concern.
- Prepared by AFPMB.

Office of the Deputy Under Secretary of Defense for Installations & Environment



Regional Disease Vector Ecology Profile

South Central Asia



Defense Pest Management Information Analysis Center
Armed Forces Pest Management Board
Forest Glen Section
Walter Reed Army Medical Center
Washington, DC 20307-5001

Homepage: <http://www.afpmb.org>

September 2001

The Walter Reed Biosystematics Unit (WRBU) is a unique national resource. Its mission is to conduct systematics research on medically important arthropods and to maintain the U.S. mosquito collection. The WRBU is just one part of the U.S. Government's entomological research system, which includes the U.S. Department of Agriculture (USDA) and the Smithsonian Institution (SI). Historically, mosquito identification was managed by USDA and the SI, but in 1972 this responsibility was transferred from USDA to the U.S. Army for research on medically important arthropods. Located at the Museum Support Center of the Smithsonian Institution in Suitland, Maryland, the WRBU's physical space is provided by the Smithsonian Institution in return for curation of the collection and specimen identification... [\(more\)](#)

What's New?

Mosquito Classification 2010 

Discussion Forum

New mosquito identification keys

See new WRBU staff publications



MosquitoMap.org
SandflyMap.org
TickMap.org



Vector Identification Resources

to medically important arthropods and WRBU's Vector Identification Service

Mosquito Resources



Culicidae Catalog
www.mosquitocatalog.org



Mosquito Genera



Mosquito Literature



Medically Important Mosquitoes



Mosquito Species
Identification Keys

Other Vectors



Sand Flies



Ticks



Scorpions



Fleas

<http://wrbu.si.edu/>



- Comprised of MosquitoMap, SandflyMap and TickMap
- Geospatially referenced clearinghouses for arthropod disease vector species collection records and distribution models.
- Users can pan and zoom to anywhere in the world to view the locations of:
 - past **vector collections** and
 - the **results of modeling that predicts the geographic extent of individual species.**

<http://mosquitomap.nhm.ku.edu/vectormap/>

VectorMap is new and still in the test phase.
Requires you to download Silver Light freeware from
Microsoft.

Model of *Plasmodium falciparum* in 2005 from the Malaria Atlas Project

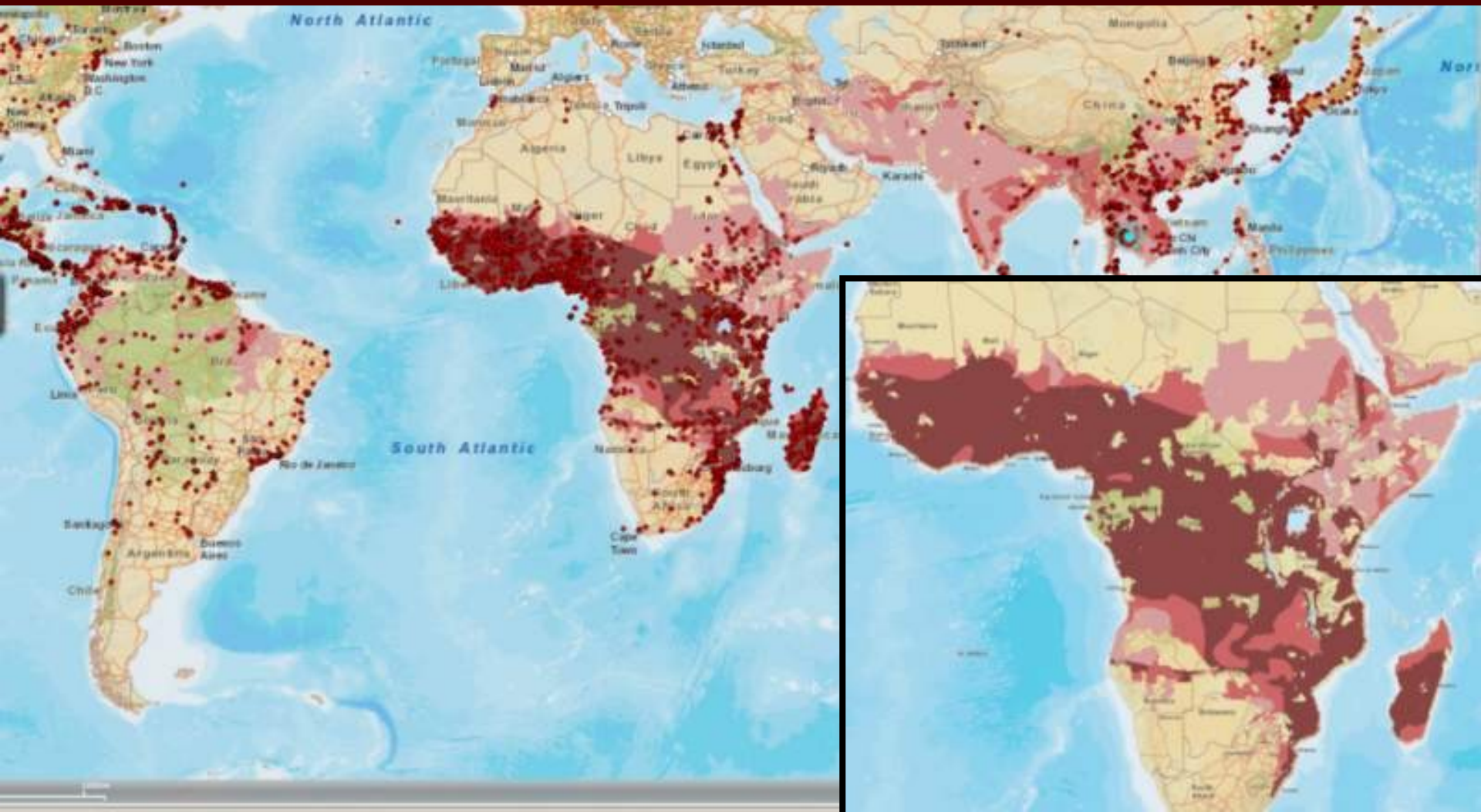
<http://www.map.ox.ac.uk/index.htm>.

Hypoendemic, Mesoendemic and Hyper-holoendemic

Several sources of information on malaria risk (notably international travel health guidelines on malaria chemoprophylaxis, altitude limits for dominant vectors, climate limits for malaria transmission and human population density thresholds) have been combined in a GIS to generate this map. See Guerra et al. (2006) *Advances in Parasitology* 62: 157 – 179 and Guerra et al. (2006) *Trends in Parasitology* 22: 353 – 358 for details.

The method for defining the endemic levels within these limits can be found in Snow et al. (2005) *Nature* 434: 214 – 217.

Anopheles collection records show up as red dots



Tick collection records



Emerging and Neglected Vectorborne Disease Threats

- Malaria
 - Dengue
 - Chikungunya
 - Zika
 - Filariasis
- Mosquito**
- Leishmaniasis
 - Rickettsioses
- Sand Fly**
- (e.g. CCHF, African tick bite fever)
- Tick**
- African Trypanosomiasis
 - Onchocerciasis
- Tsetse Fly**
- Black Fly**

What is a vector?

- An arthropod that becomes infected with a pathogen and is able to transmit it to another host.
- Although an arthropod is able to maintain a parasite alive within its body, transmission depends upon its competence as a vector.
- Requires a blood meal to reproduce; spreads disease incidentally.

Blood required for egg development



Vector Potential

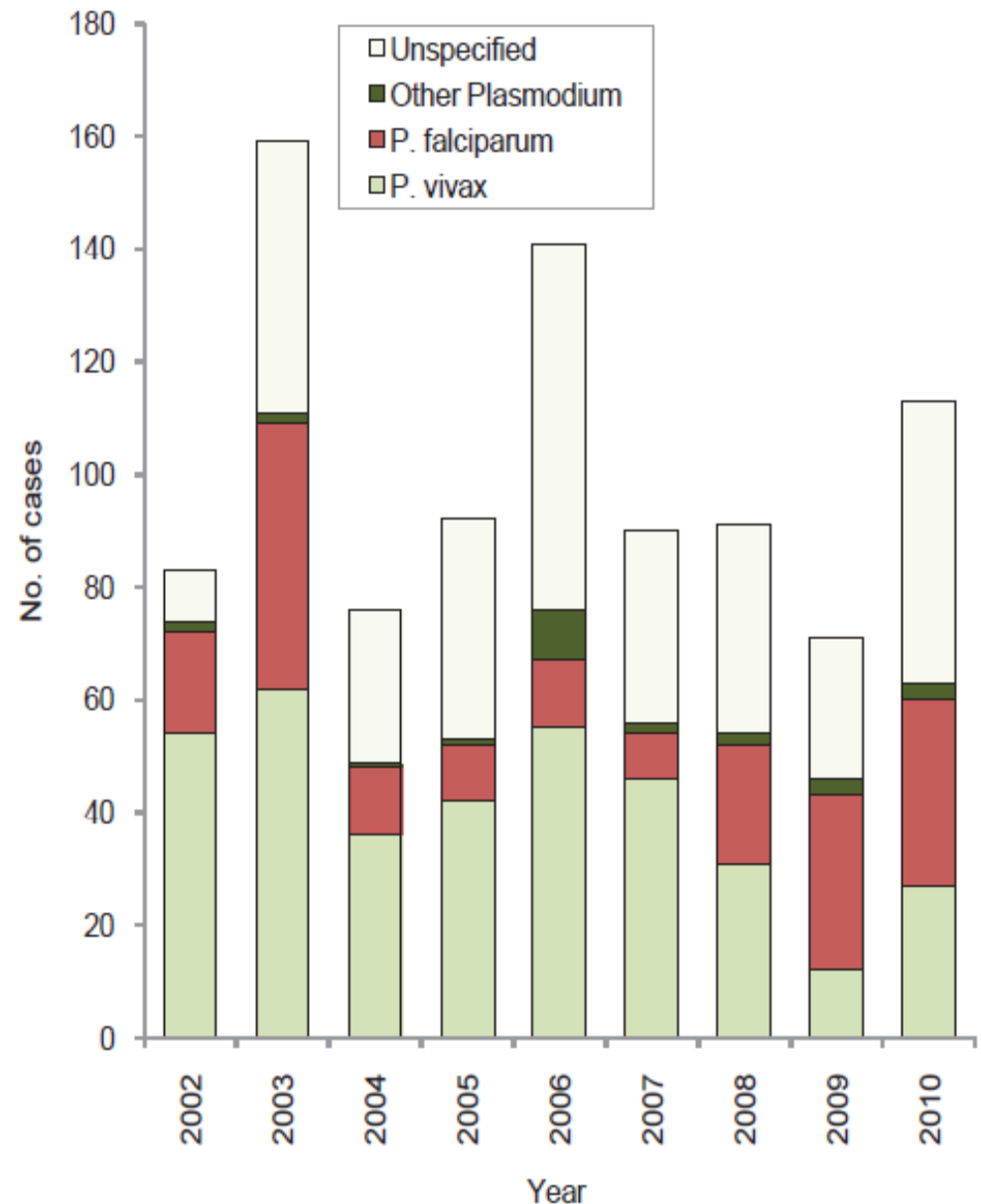
- Mosquito species vary in their vector potential because of environmental conditions and factors affecting their **abundance, blood-feeding behavior, survival, and ability to support parasite development (this all influences competence)**
- Sporogony is the complex life cycle of the malaria parasite in female mosquitoes; completed life cycle is necessary for disease transmission.
- Most individual mosquitoes that ingest gametocytes from the reservoir or host do not support development to the sporozoite stage.

Malaria- Anopheles mosquitoes



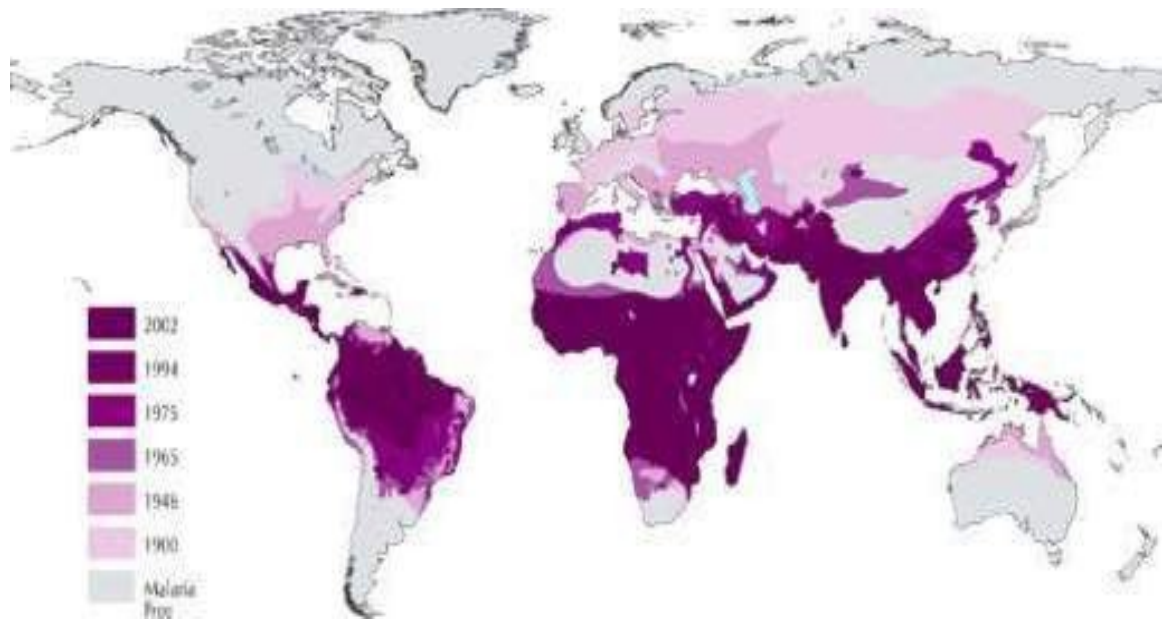
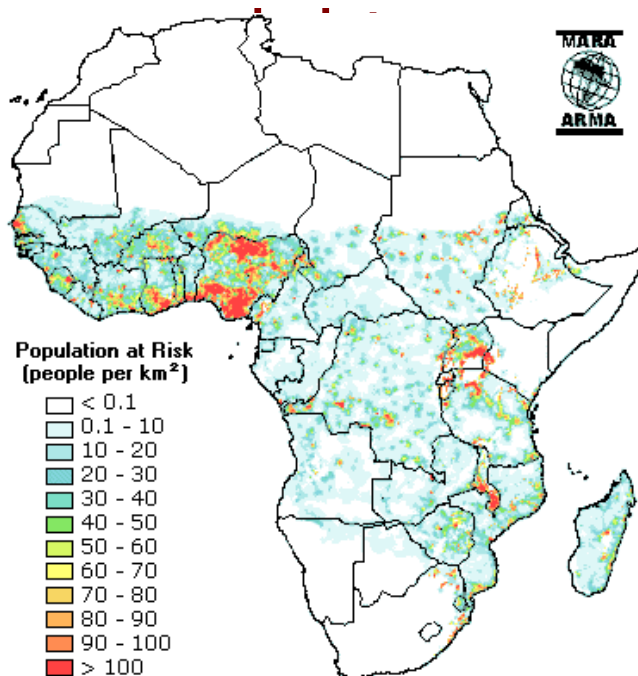
**~100 cases per year
in US forces in AFG;
likely under
reported**

Figure 1. Malaria cases among U.S. service members, by *Plasmodium* species and calendar year of diagnosis/report, 2002-2010



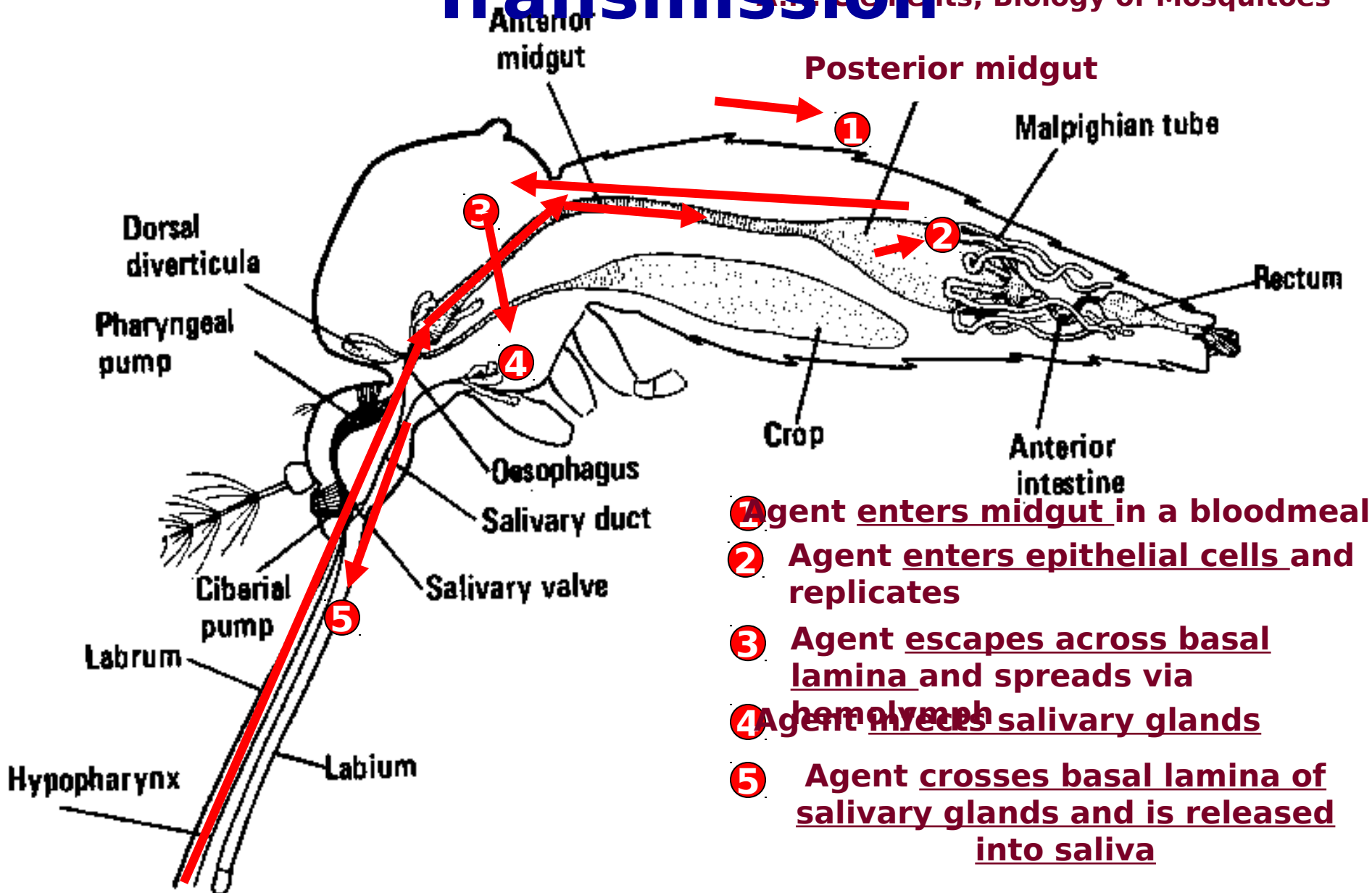
Malaria- *Anopheles* mosquitoes

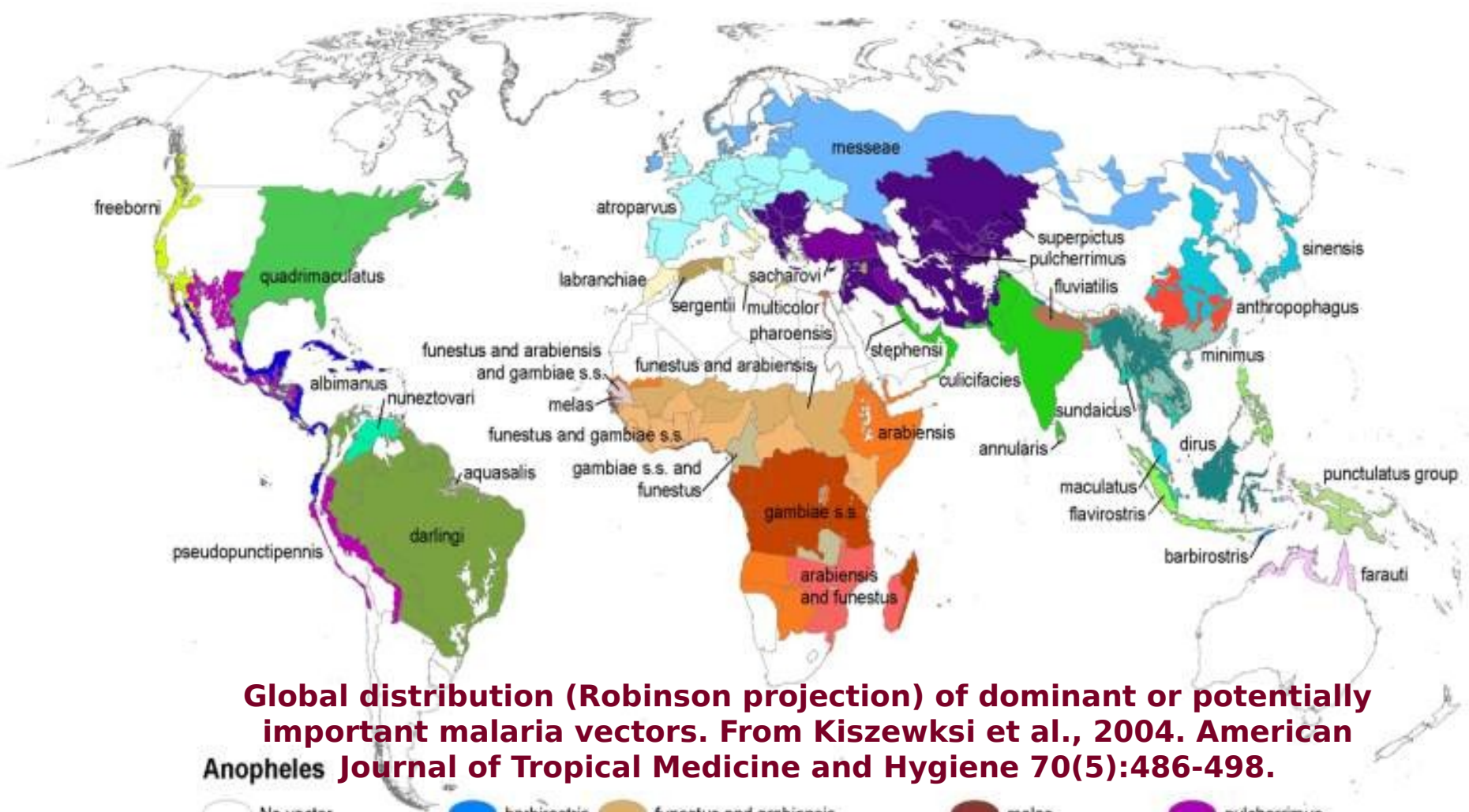
- Risk varies geographically
 - Different species of ***Anopheles*** mosquitoes (varying competence)
- Entomological inoculation rate (EIR).
 - An estimate of exposure to infective mosquitoes,
 - EIRs can exceed 1 infective bite per person per



Barriers to Pathogen Transmission

A.N. Clements, Biology of Mosquitoes





○ No vector	● barbirostris	● funestus and arabiensis	● melas	● pulcherrimus
● albimanus	● culicifacies	● funestus, arabiensis and gambiae s.s.	● messeae	● quadrimaculatus
● annularis	● darlingi	● funestus and gambiae s.s.	● minimus	● sacharovi
● anthropophagus	● dirus	● gambiae s.s.	● multicolor	● sergentii
● arabiensis	● farauti	● gambiae s.s. and funestus	● nunez-tovari	● sinensis
● arabiensis and funestus	● flavirostris	● labranchiae	● punctulatus group	● stephensi
● aquasalis	● fluviatilis	● maculatus	● pharoensis	● sundaicus
● atroparvus	● freeborni	● marajoara	● pseudopunctipennis	● superpictus

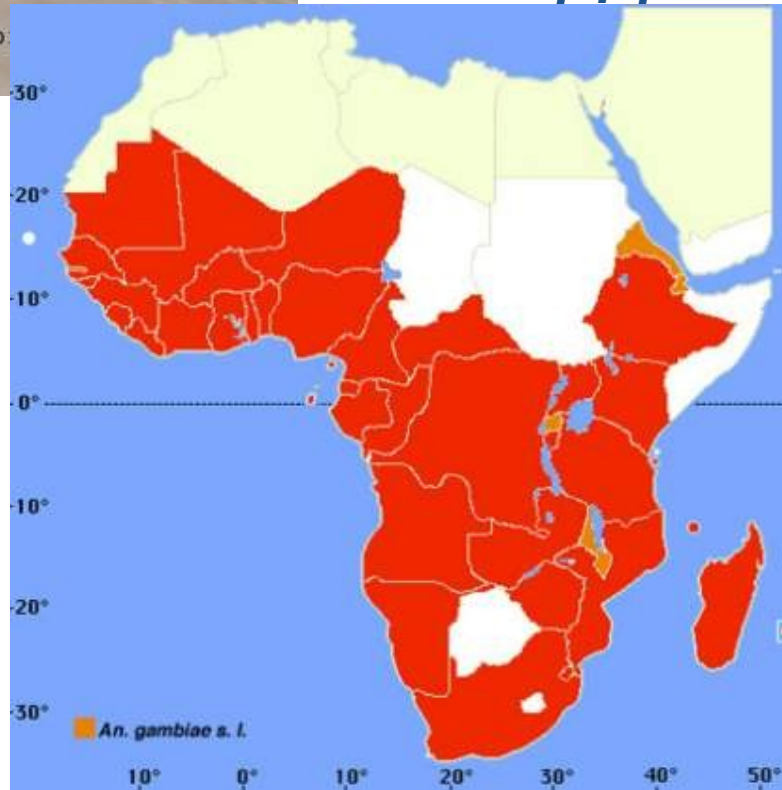
Anopheles gambiae complex

Anopheles arabiensis
Anopheles bwambae
Anopheles merus
Anopheles melas
Anopheles quadriannulatus
Anopheles gambiae sensu



Anopheles gambiae / photo:

***An. gambiae* s. str.:**
very
anthropophilic,
night biter;
Africa's primary
malaria vector



Biology of *Anopheles* spp.

Eggs

- Eggs are laid individually on the water surface and are kept afloat by air chambers (floats)
- Females lay batches of **75 to 150 eggs**
- The eggs hatch after two or three days at temperatures of 25-30°C
- At lower temperatures, this period can be longer, and the eggs can resist total or partial desiccation in moist soil for many days (up to years)
- Oviposition (egg laying) sites vary by species



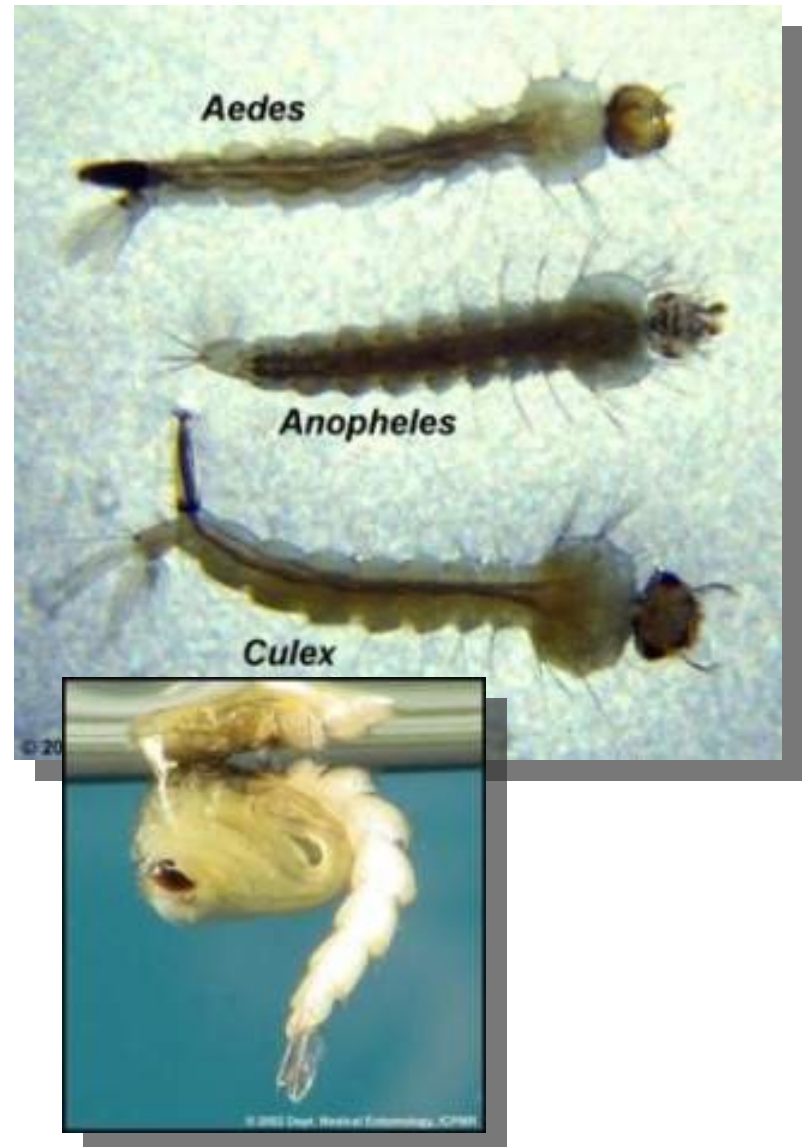
Biology of *Anopheles* spp.

Larvae

- Characteristic resting position, lying parallel to the water surface
- Larval development takes around 5 to 7 days depending on temperature
- Larval habitat varies with species

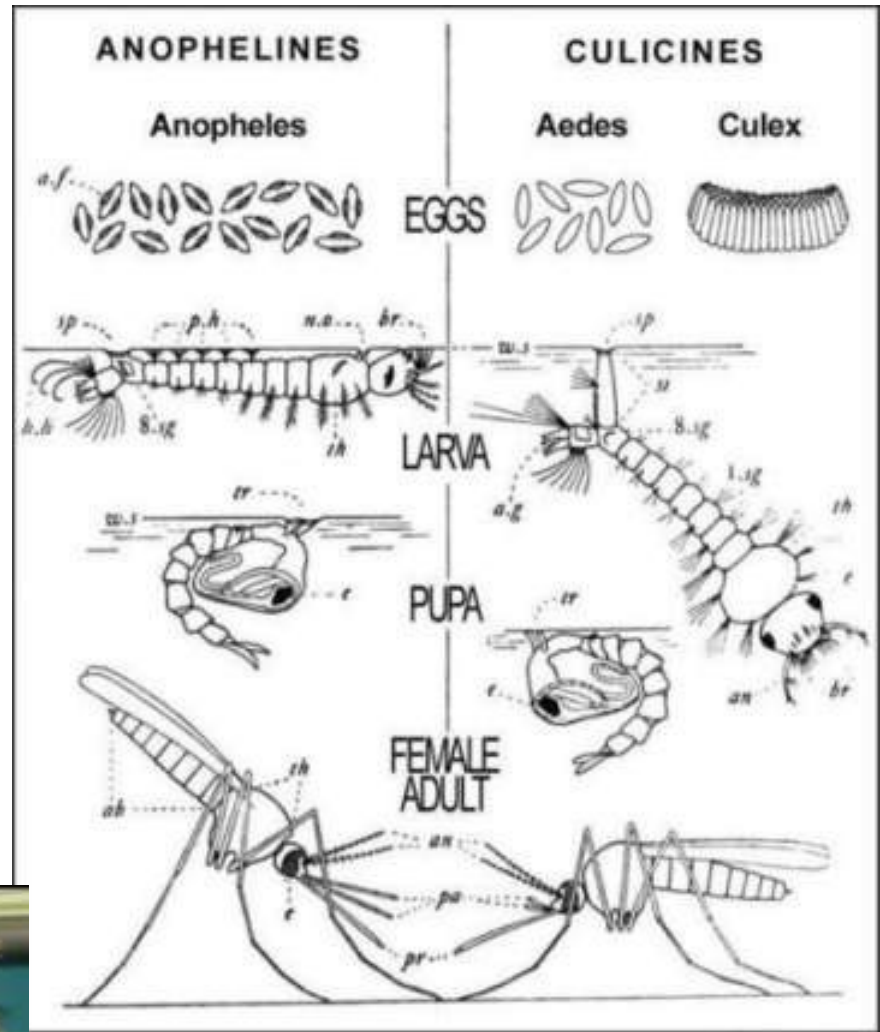
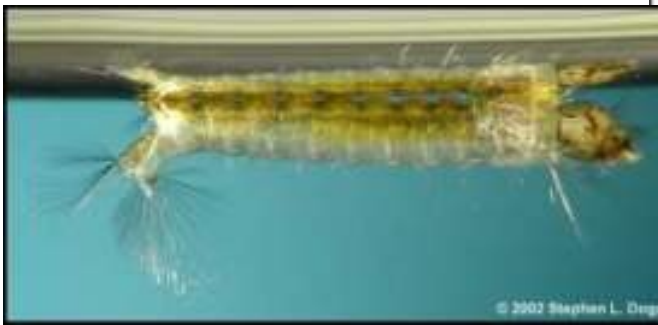
Pupae

- Pupae do not eat
- Metamorphosis of the larva into an adult
- It lasts from two to three days



Biology of *Anopheles* spp.

- Larvae lack a siphon
- Larvae rest parallel to water surface
- Breathe through spiracle on 8th body segment
- Adults hold body at an angle of 30° degrees or more with the surface.



Biology of *Anopheles* spp.

Adult:

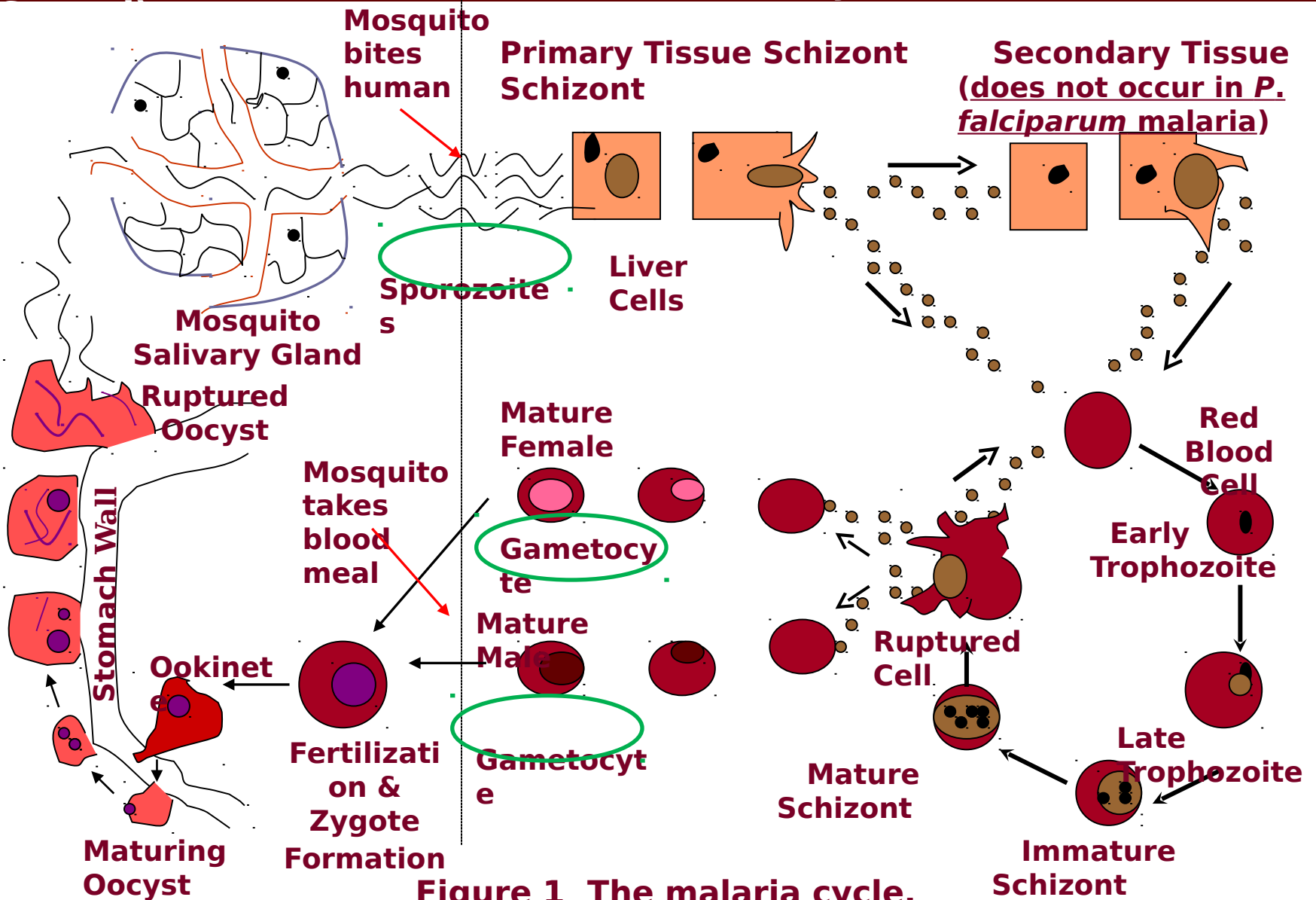
- Live from 3 to 4 weeks although some can overwinter.
- Feeding occurs at night (dusk to dawn).
- Host preference varies by species.
- **Indoor vs. outdoor feeding.**
- **Complicated sexual stage of parasite life cycle occurs in mosquito**



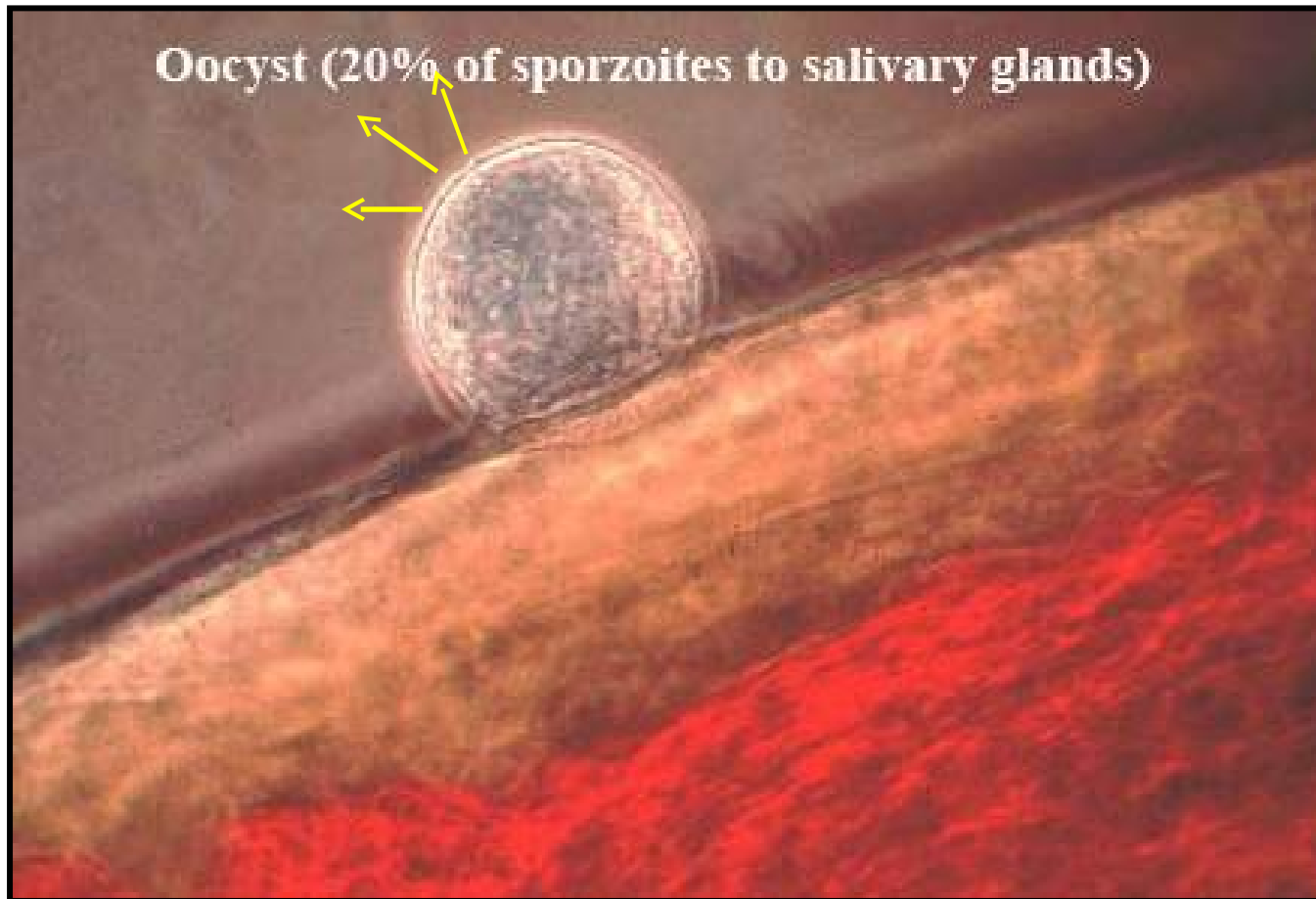
2 *falciparum* Transmission Cycle

Cycle in Mosquito

Cycle in Man



Life cycle - Sexual stage



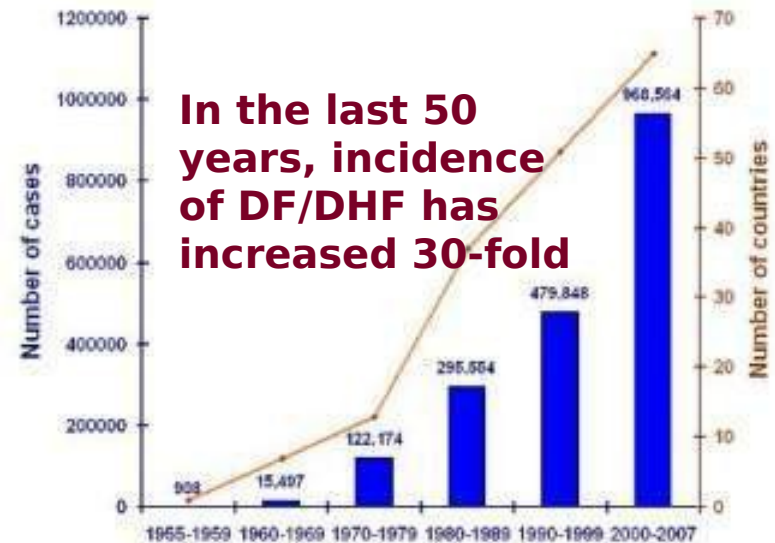
Dengue- Aedes

quite

Laboratory-Confirmed DHF in the Americas Prior to 1981 vs. 1981 - 2003



Average annual number of DF/DHF cases reported to WHO & average annual number of countries reporting dengue



In the last 50 years, incidence of DF/DHF has increased 30-fold

Emergence of DEN/DHF



- Endemicity has increased from 9 countries to over 100 countries since the 1970s
- The dengue transmission cycle occurs in the US
- No vaccine; treatment basically limited to supportive care
- As of fall 2013:
 - The Americas- 876,859 cases; 406 DHF/serious
 - Vietnam- 13,903 cases

-First case of secondary transmission in Miami in 50 years in Nov 10; 2 cases in 2011; first case of secondary transmission in Tampa diagnosed in Oct 2011; 4 cases in 2012; 28 cases in 2013

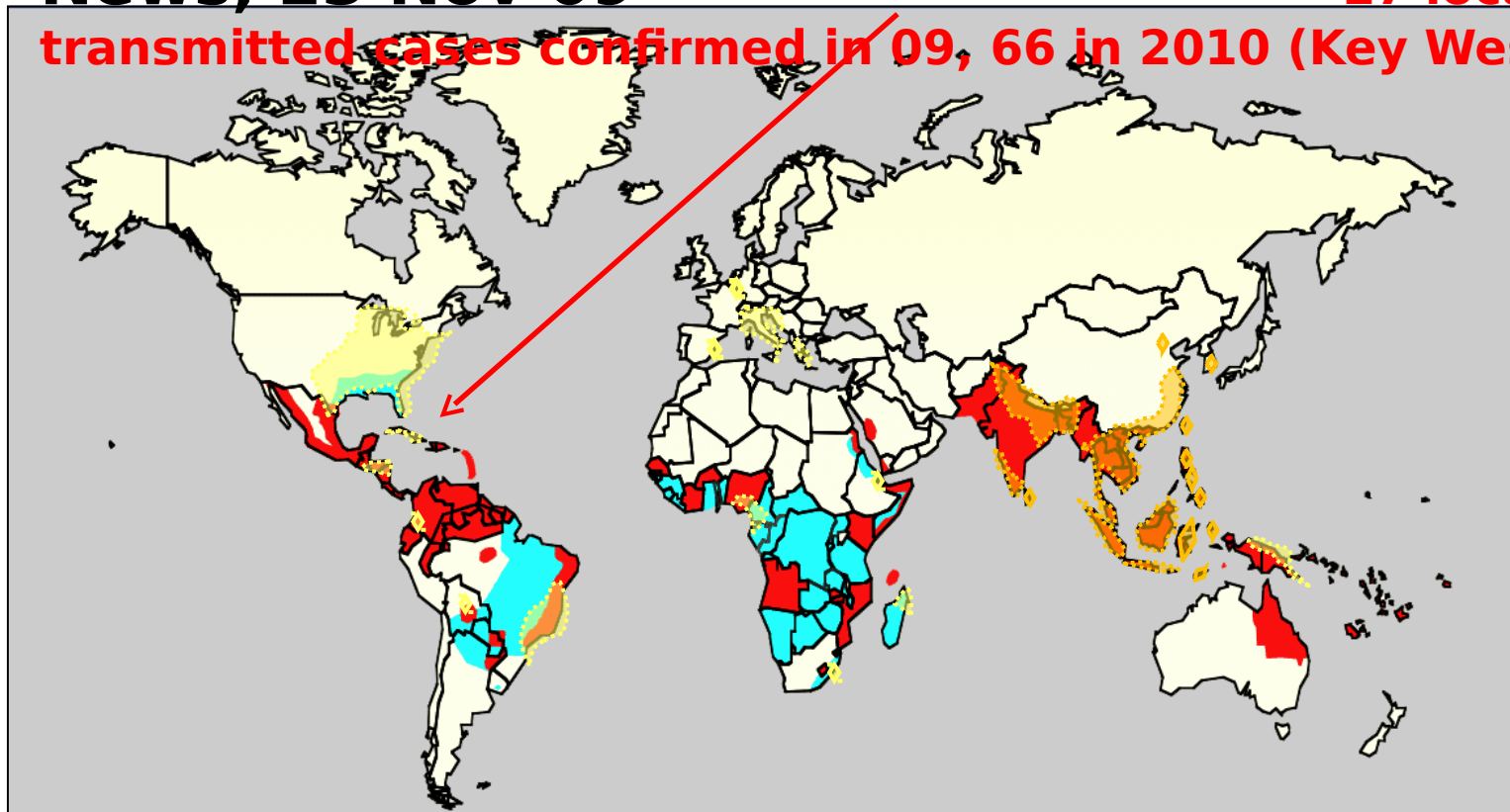
~~Martin County outbreak~~

“Dengue virus returns to Florida after more than 50 years, UF researchers say” UF News, 23 Nov 09

-27 locally transmitted cases confirmed in 09, 66 in 2010 (Key West)

V
E
C
T
O
R

I
N
F
L
U
E
N
C
E



Epidemic dengue:

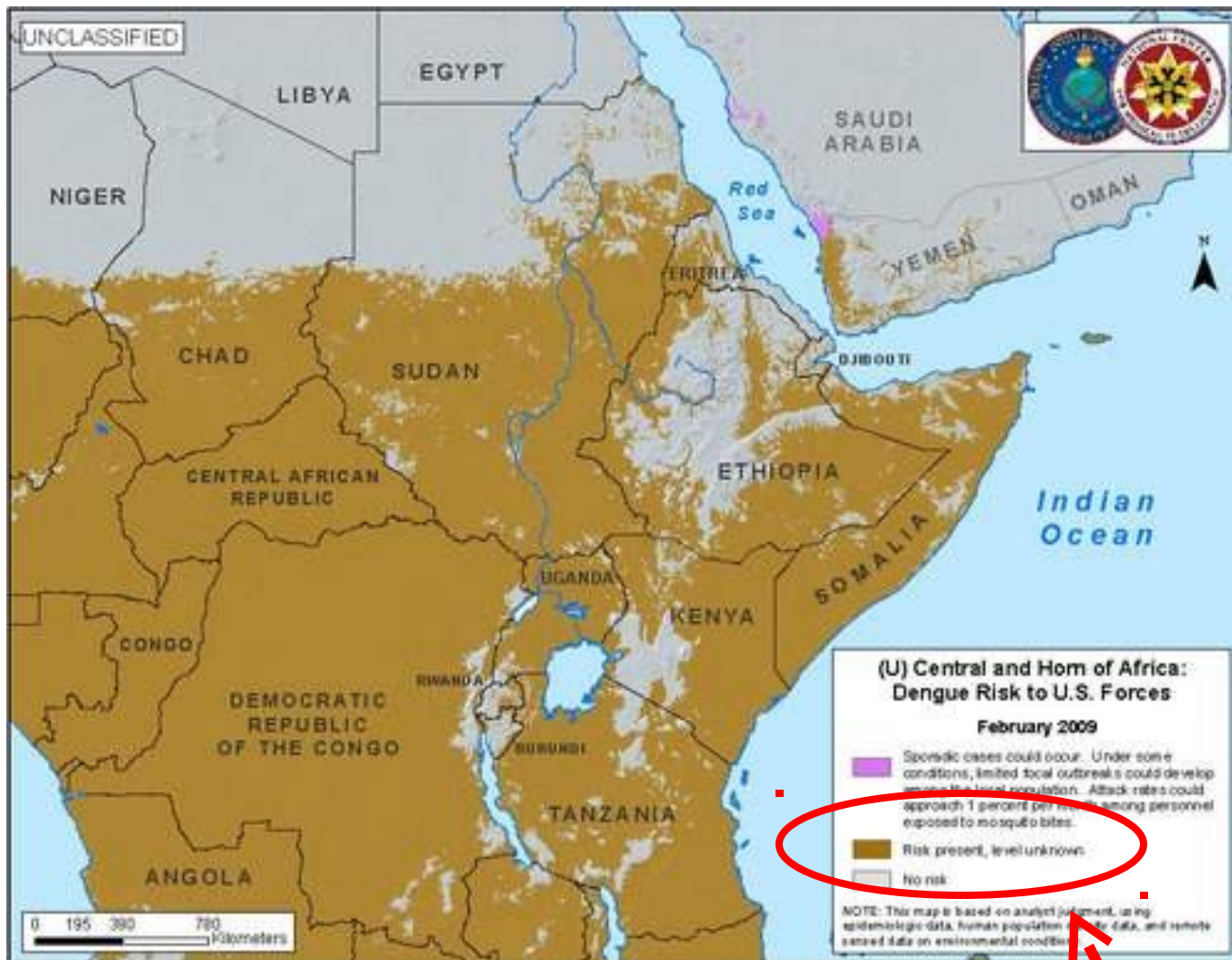
***Ae. aegypti* distribution:**

***Ae. albopictus* native range:**

***Ae. albopictus* introduction since Dec 07:**



Dengue in Africa



“Risk present, level unknown”

Chikungunya Fever-

Aedes mosquitoes

From 2006 to 2010, 100 laboratory-confirmed or probable cases of chikungunya were detected among travelers returning to the United States. This compares with only three cases reported from 1995 to 2005. Since 2004, chikungunya virus has caused massive and sustained outbreaks in Asia and Africa, infecting more than 2 million people, with attack rates as high as 68% in some areas. With the movement of travelers, local transmission has taken place in areas where the virus was not previously found, including northern Italy and

<http://new.paho.org/hq/index.php?>

PREPAREDNESS AND RESPONSE FOR CHIKUNGUNYA VIRUS INTRODUCTION IN THE AMERICAS



Preparedness and Response for Chikungunya Virus

Introduction in the Americas



Chikungunya Fever- Aedes mosquitoes

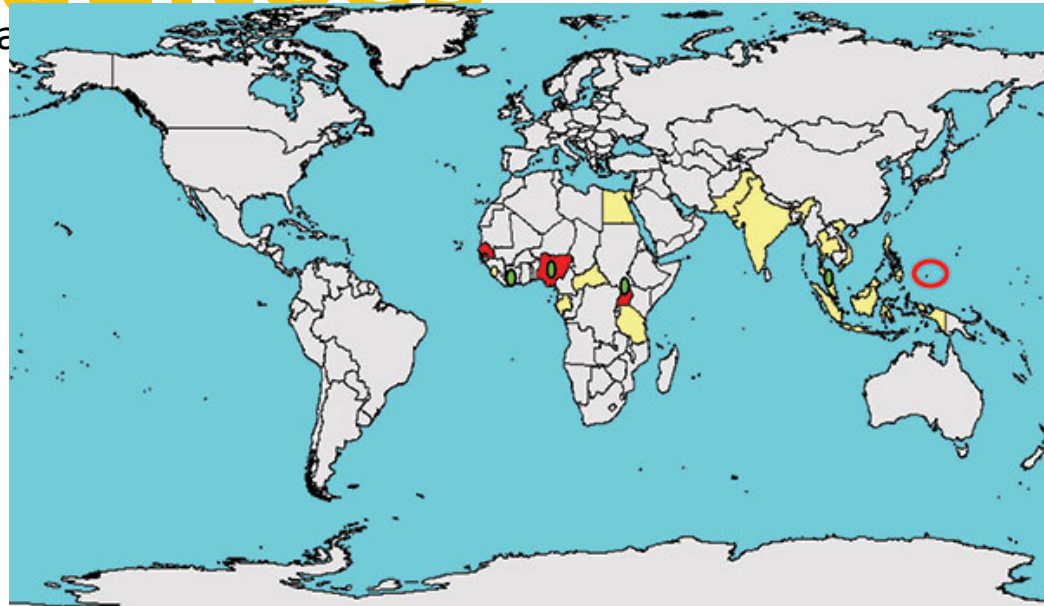
- Mosquito-borne virus
- Like dengue, traditional vector is *Ae. aegypti* but *Ae. albopictus* is competent vector; equivalent eradication challenges
- Symptomology also comparable to dengue
- Continuous outbreaks since 2005 in Europe, Asia & Africa, to include areas not previously endemic; over 200 cases in Italy in 2007
- Jun 11- Based on genomic studies from an outbreak of 480 cases in DRoC, *Ae. albopictus* is being considered as a more critical vector



- **Malaysia: Over 1,100 cases Jan - April 2009**
- **Philippines: Over 500 cases by Oct 2013**

Zika Virus- Aedes mosquitoes

- The French Polynesia Department of Health has confirmed an outbreak of Zika fever in the islands of French Polynesia. As of January 13, 2014, 361 laboratory confirmed cases and 7,156 suspected cases have been reported
- Related to dengue, Yellow Fever, West Nile and JE
- Hosts are monkeys and humans
- ~10 day mosquito development stage
- Similar symptoms to dengue, CHIK-V



Approximate distribution



**Ae.
aegypti**

Filariasis- Mosquitoes

Vector depends on the geographic area

- Africa: *Anopheles quinquefasciatus*
- Americas: *Culex*
- Pacific and Asia: *Aedes* and *Mansonia*

Biting behaviors matter!



Aedes Vectors



Ae. albopictus



Ae. aegypti

Feeding Habits - *Ae. albopictus*

- *Aedes albopictus* prefers to feed and rest **outdoors**
- Feeds during daytime (diurnal)
- Feeds on any vertebrate host but prefers humans





Aedes comparison

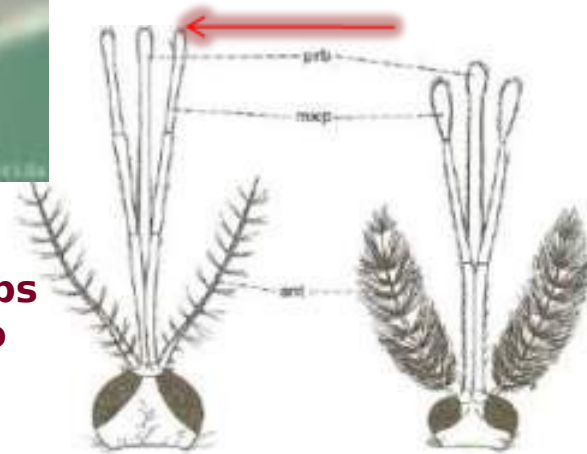
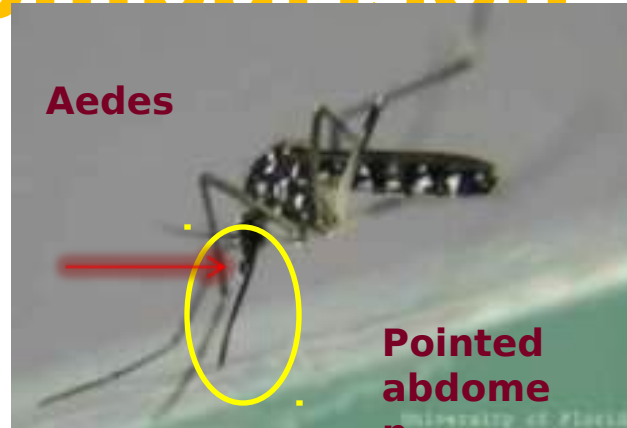
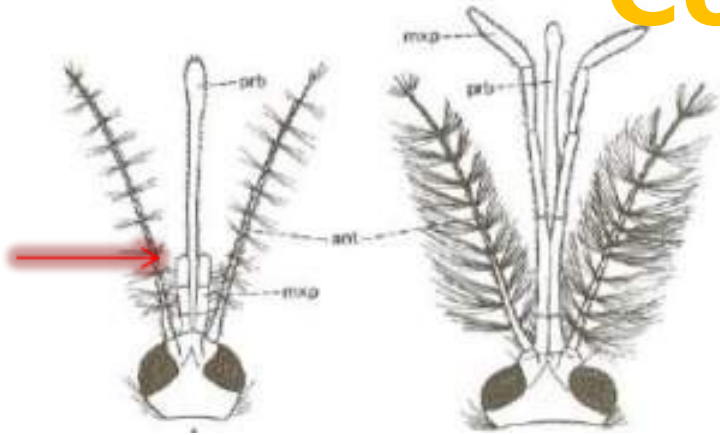


Ae. aegypti ***Ae. albopictus***

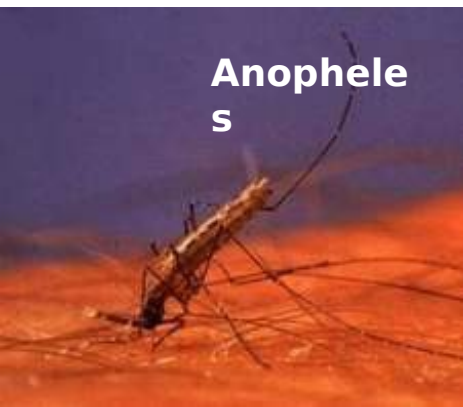
Environment	Urban	Sylvatic*
Breed/feed	Indoors(< 200m)	Outdoors
Container type	Artificial	Natural and artificial
Biting peak	Daytime	Dusk
Host	Human	Human/Vertebrates
Flight Range	< 200m	< 600m

*Not necessarily

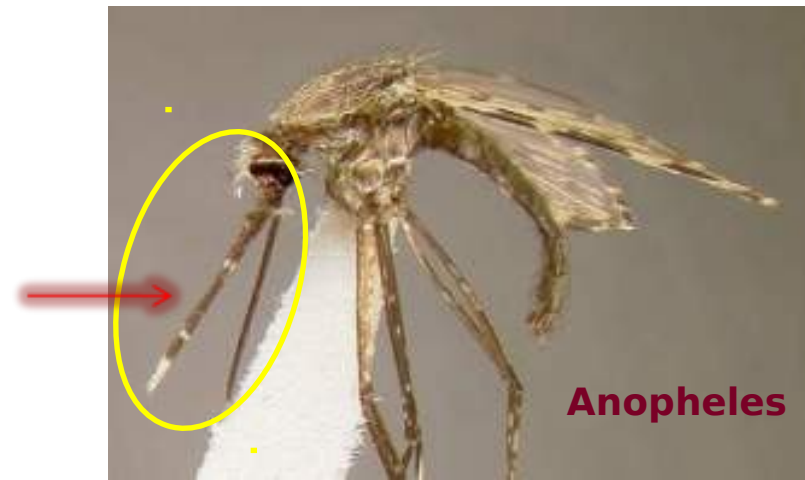
Mosquito Vector Comparison



Length of palps compared to proboscis



Resting and Feeding behavior



Behavior & Habitat Comparison



Aedes, Culex:
stagnant, dirty,
temp pools,
opportunistic



Aedes, Culex:
body hangs
down from the
surface; uses

Anopheles:
parallel to
surface;
spiracular plates
on 8th abdominal
segment



Anophelines: typically
cleaner, slowly
flowing; in some
places temp pools ok
as long as not
stagnant

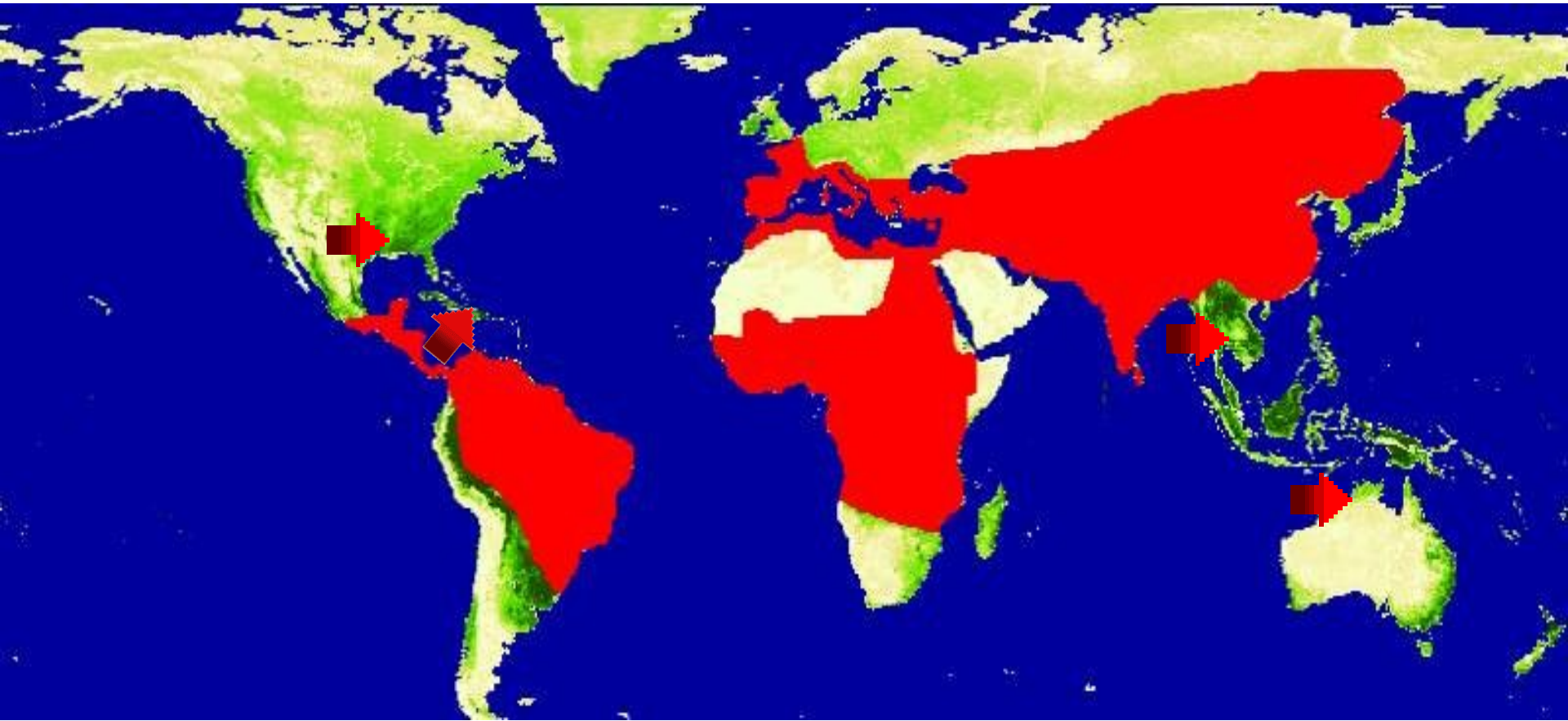


© 2002 Stephen L. Drigg

Sand Flies-



Global distribution of the leishmaniases (but not the global distribution of sand flies)



**B
I
T
I
N
G

B
E
H
A
V
I
O
R**





**Mucocutaneous
leish from French
Guyana**



The Epidemiological Triangle

Enzootic Cycle

Sand fly vector



Mammalia Reservoir
home to the pathogen



Incidental Host



Man and his Activities



Psammomys obesus



Chenopods

***L. major* enzootic cycle**

Characteristics

- Small (2-3 mm)
- Brown (but appear white when illuminated)
- Wings held in erect V-shape (even dead)
- Nocturnal
- Do not hover
- Silent
- Painful bite for some



Leishmaniasis Sand Flies



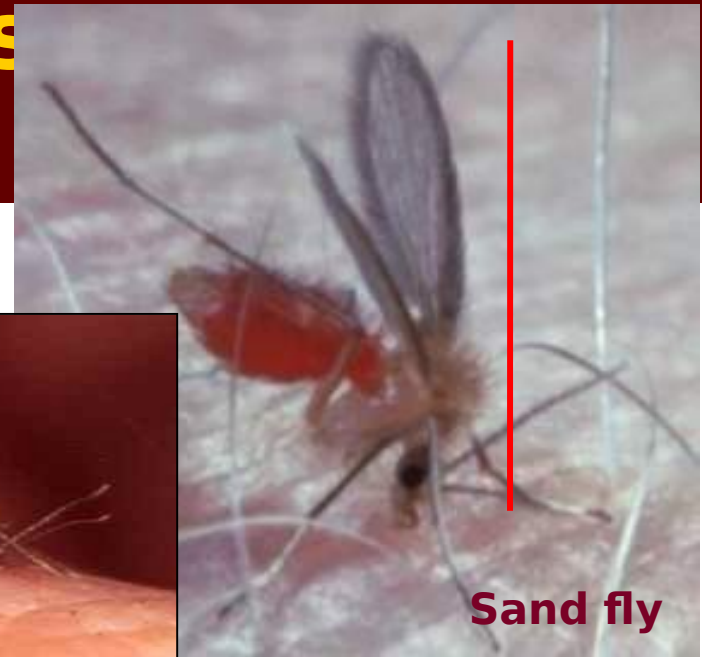
Drain fly



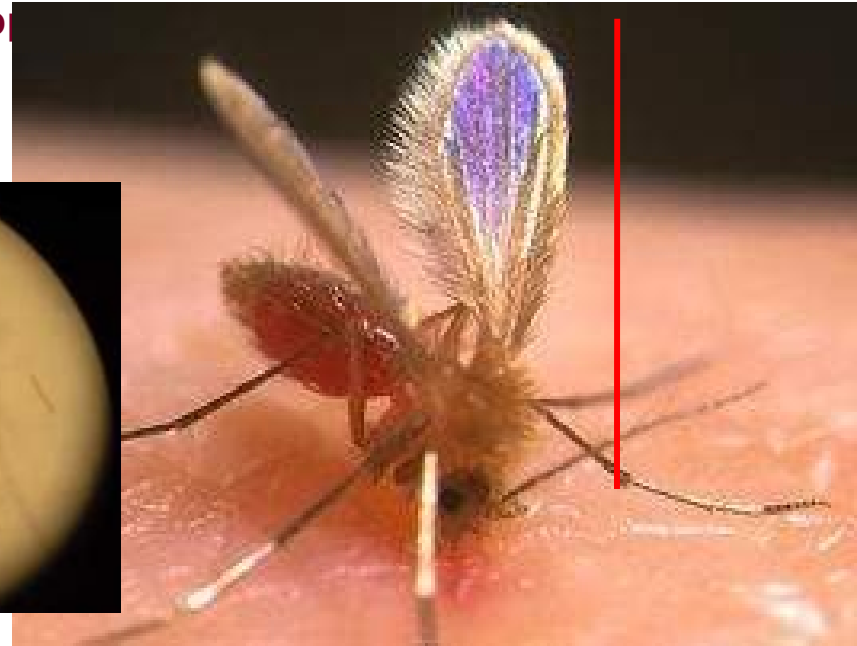
Damp habitats, plumose antennae, larger, broader wings, more hair; sand fly always holds its wings up and away from its body, not flat like a drain fly



Phlebotomus (Old World) and *Lutzomyia* (New World) spp.



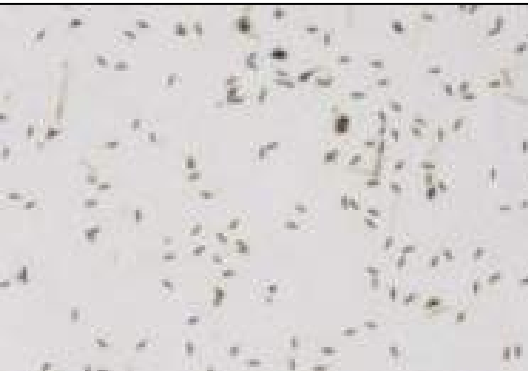
Sand fly



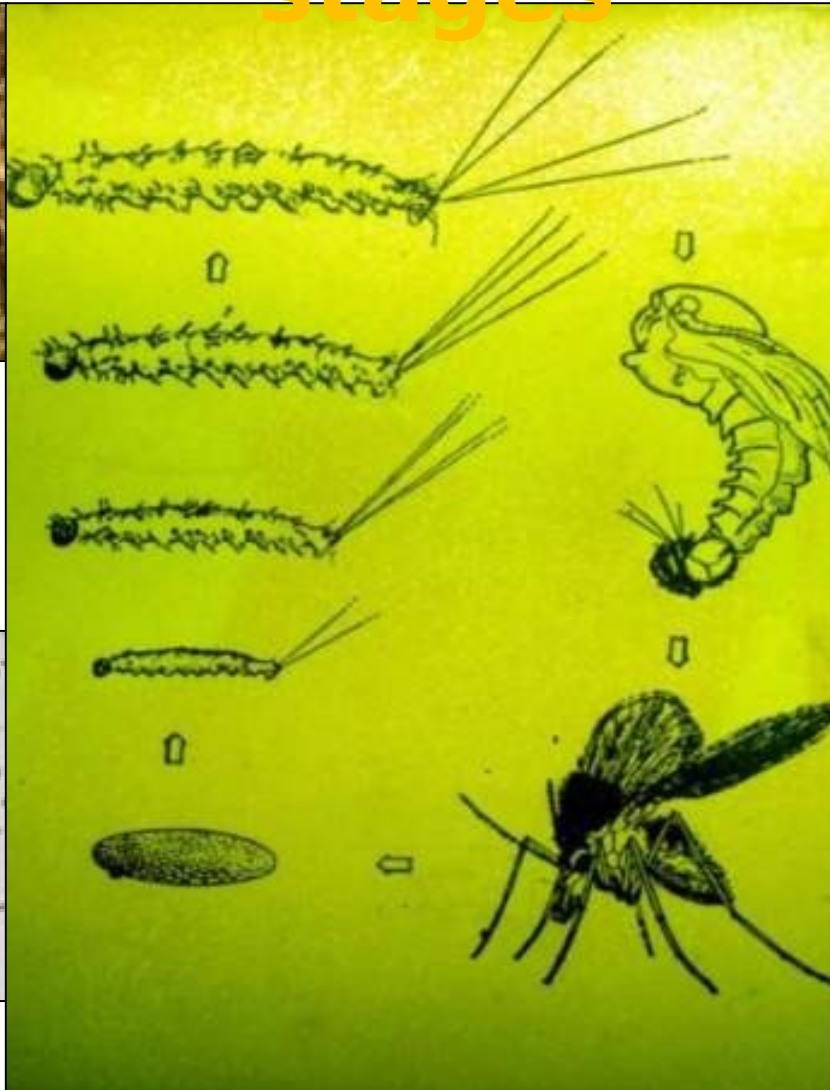
Life cycle and developmental stages



**Fourth instar
larvae**



Eggs



Life cycle



Adult male



Adult female

Sand flies - vital requirements

- Larvae breed in soil (not aquatic)
- Only females take blood, from a variety of vertebrate species
- Rest during the day in dark, humid microhabitats
- Both sexes require sugar as an energy source

Sand flies resting on wall of a chicken house



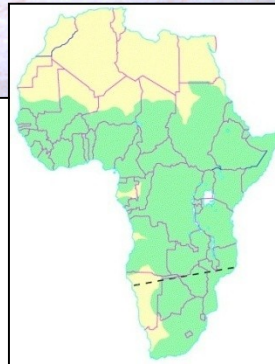
Variable Habitats: rain forest, desert,



African Tick Bite Fever- Ticks

African tick-bite fever
(ATBF)

- an emerging infectious disease endemic in sub-Saharan Africa
- the most commonly encountered rickettsiosis in travel medicine.
- *Rickettsia africae*
- *Amblyomma*, *Dermacentor*, *Rhipicephalus*



1. Ndip et al., 2011. Risk Factors for African Tick-Bite Fever in Rural Central Africa. *Am. J. Trop. Med. Hyg.*

2. Raoult et al., 2001. *Rickettsia africae*, a tick-borne pathogen in travelers to sub-Saharan Africa. *N Engl J Med*

Crimean Congo Hemorrhagic Fever- Ticks

- **Sep 09: First US Soldier death from CCHF since WWII; acquired in AFG (Arghandab Valley)**
- Tick-borne virus (*Hyalomma*); 30% mortality rate
- **Can also be transmitted by exposure to fresh infected blood (human or animal)**
- Endemic in many countries in Africa, Europe, Asia and the Mediterranean; since 2001 cases or outbreaks have been recorded in Kosovo, Albania, Iran, Pakistan, and South Africa
- **Most widely distributed HF in the world**
- **Austere conditions increase the likelihood of transmission; fewer “tick checks”, formal or informal**
- Intensive monitoring of blood volume and component required

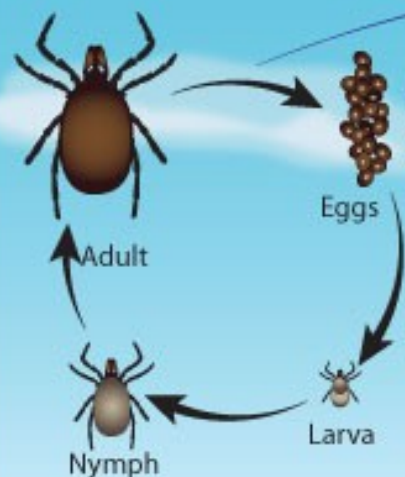


Crimean-Congo Hemorrhagic Fever (CCHF) Virus Ecology

Enzootic Cycle

Ixodid (hard) ticks are both a reservoir and vector for the CCHF virus.

The virus is maintained in nature transovarially and transstadially.



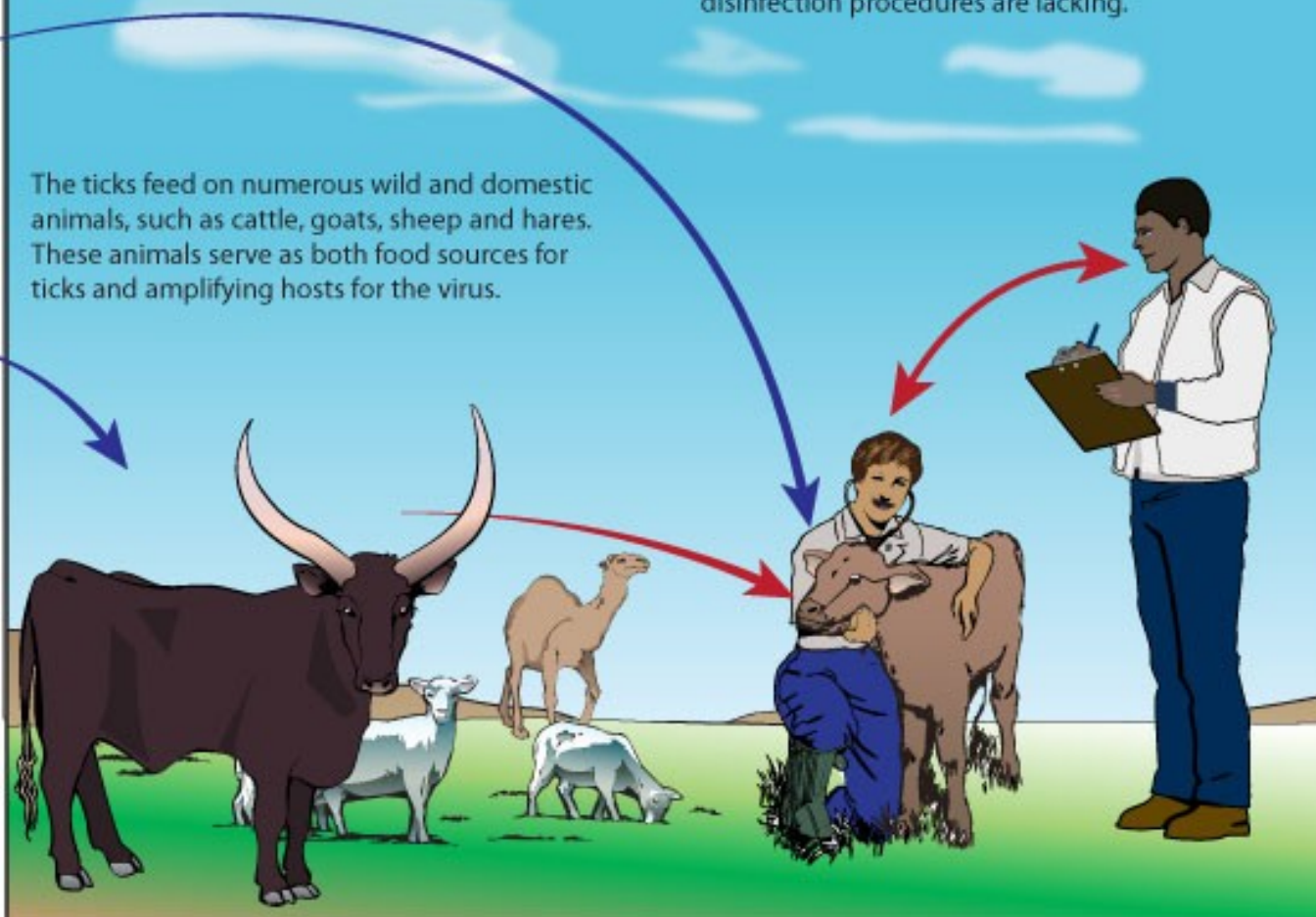
Epizootic-Epidemic Cycle

CCHF cases occur more during the warmer parts of the year, mostly the spring and summer. There are no cases during the winter.

Humans become infected through tick bites and direct contact with infected animal blood or tissue.

Transmission can occur while slaughtering infected animals, during veterinary procedures, and in hospital settings where proper protective equipment and appropriate disinfection procedures are lacking.

The ticks feed on numerous wild and domestic animals, such as cattle, goats, sheep and hares. These animals serve as both food sources for ticks and amplifying hosts for the virus.





Tick Removal

U. S. Army Center for Health Promotion and Preventive Medicine

REMOVE TICKS PROMPTLY

★ If a tick is found attached to the body (Figure 1), seek assistance from medical authorities for proper removal, or follow these guidelines:

(1) **Grasp the tick's mouthparts** against the skin, using pointed tweezers (Figure 2).

(2) **Pull back slowly and steadily** with firm force.

(a) Pull in the reverse of the direction in which the mouthparts are inserted, as you would for a splinter (Figure 2).

(b) **BE PATIENT** – The long, central mouthpart (called the hypostome) is inserted in the skin. It is covered with sharp barbs, sometimes making removal difficult and time-consuming (Figure 3, inset).

(c) Most ticks secrete a cement-like substance during feeding. This material helps secure their mouthparts firmly in the flesh, further adding to the difficulty of removal.

(d) It is important to continue to pull steadily until the tick can be eased out of the skin (Figure 3).

(e) **DO NOT** pull back sharply, as this may tear the mouthparts from the body of the tick, leaving them embedded in the skin. If this happens, do not panic. Embedded mouthparts are comparable to having a splinter in your skin. Mouthparts alone cannot transmit disease because the infective body of the tick is no longer attached. However, to prevent the chance of secondary infection, it is best to remove them. Seek medical assistance if necessary.

(f) **DO NOT** squeeze or crush the body of the tick because this may force infective body fluids through the mouthparts and into the wound site.

(g) **DO NOT** apply substances such as petroleum jelly, finger nail polish, finger nail polish remover, repellents, pesticides, or a lighted match to the tick while it is attached. These materials are either ineffective, or worse, might agitate the tick and cause it to force more infective fluid into the wound site.

★ Following removal of the tick, wash the wound site (and your hands) with soap and water and apply an antiseptic.

★ **Save the tick** for future identification should you later develop disease symptoms. Preserve it by placing it in a clean, dry jar, vial, small Ziploc plastic bag, or other sealed container and keeping it in the freezer. Identification of the tick will help the physician's diagnosis and treatment, since many tick-borne diseases are transmitted only by certain species.

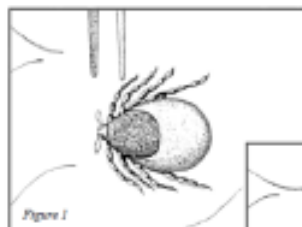


Figure 1

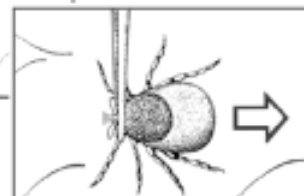


Figure 2



Figure 3

★ You may discard the tick after one month; all known tick-borne diseases will generally display symptoms within this time period.

★ A tick needs a blood meal from a host in order to molt (progress to the next stage of its life cycle), and to reproduce (lay eggs). This feeding process continues for several days to a week until the tick is fully engorged with blood. It then releases its hold on the host, drops off, and subsequently molts or lays eggs.

★ If the tick is infected with pathogenic organisms (for example, *Borrelia burgdorferi*, the agent of Lyme disease), it can transmit the infection to the host during the feeding process. As the tick feeds, the pathogens multiply, migrate to the tick's salivary glands, and are carried into the wound site along with the saliva.

★ Successful transmission of pathogens requires the tick to be attached for at least several hours. Therefore, the sooner infective ticks are removed, the less likely they will be able to transmit infection. It is impossible to tell if a tick is infected just by looking at it. Only analysis in a laboratory can determine infection status.



HAT and



Over 50% of the landcover in Africa is considered "highly suitable" to the tsetse fly; both sexes take blood



African Trypanosomiasis

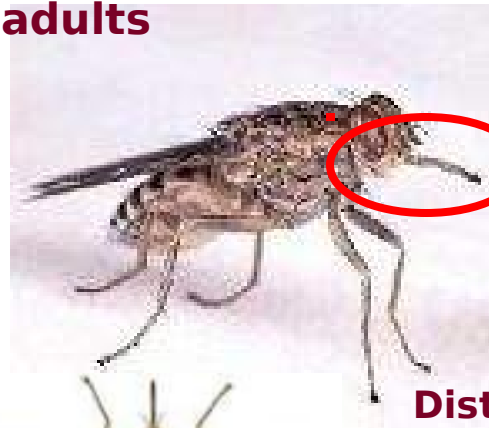


Muscidae
sp.

Larvae are soil dwelling so
control measures target adults



Glossinidae



Distinct features: long proboscis,
calyptrate antennae, ptilinal suture, the wings overlap completely when held over the abdomen, the discal medial (i.e. the middle) cell of the wing has a characteristic hatchet shape; and it has



Onchocerciasis- Black Flies



- Simulium* complex breed in fast-flowing streams and rivers hence the commonly known name of “river blindness”

- Large flight range

- Larval stage is targeted by control programs

- Painful daytime bite; “pool feeders”, ideal for transmission of microfilarial into skin



hundreds of eggs can be laid at one time
breaks can be ecologically



Prevention

WHAT CAN YOU DO TO MINIMIZE RISK?

- Find out what the priority risks are in your area before you deploy.
- Understand the vectors so you can avoid them.
- Modify behaviors to minimize contact
 - Use **repellents**
 - Sleep under insecticide treated netting
 - Wear permethrin treated uniforms
- Take malaria chemo (if warranted)
- Call for help:
 - AFPMB (CLO) : afpmb-webmaster@osd.mil: subject CLO question
 - PHC, Ento Division

Standard Military DEET Skin Repellent



Commercial



Military

33% Controlled-Release DEET Lotion: NSN 6840-01-284-3982

Highest rated skin repellent available (Consumer Reports, May 2003; reconfirmed 2013-14)

CDC recommended repellents

- Of the active ingredients registered with the EPA, products containing these active ingredients typically provide longer-lasting protection than others:

DEET, Picaridin and IR3535

- The non-DEET compounds work as well as or nearly as well as DEET when they are used at higher concentrations (~10-20%).

<http://www.cdc.gov/ncidod/dvbid/westnile/repellentupdates.htm>

http://www.epa.gov/pesticides/health/mosquitoes/ai_inspectrp.htm

<http://www.entomology.wisc.edu/mosquitosite/topicalrepel.html>

Picaridin



- Picaridin is a colorless, nearly odorless liquid active ingredient that is recommended by the CDC as an alternative to DEET.
- Lab and field studies of products containing picaridin (**10-20%**) indicate good protection.

- 7.5% products are not as effective.

- **Natrapel, 20%**, 3.5-oz. Pump Spray
- Cutter Advanced, 7%, 6-oz. Pump Spray
- Off Skintastic, 5%, 6-oz. Pump Spray



IR3535



- IR3535 is recommended by the CDC as an alternative to DEET.
- IR3535 is a synthetic insect repellent structurally similar to a natural amino acid, beta-alanine and is classified as a biopesticide by the EPA.
- This compound has been used as a mosquito repellent in Europe and Asia for 10-20 years
- Approved by the U.S. EPA in 1999.
- IR3535 is currently available in the Avon Skin-so-soft Bug Guard **7.5%**

Treated Uniforms



- A new training briefing on permethrin-treated Flame-Resistant Army Combat Uniforms (FR ACUs) is available –CAC REQUIRED
- <https://www.us.army.mil/suite/doc/28282876>
- <https://peosoldier.army.mil/newpeo/ContactUs/faqs/fracu.asp>

Bed Nets



Enhanced BedNet System 3740-01-546-4354

Improved Bed Net System 3740-01-543-5652

**Bed net, Pop-up, self-supporting
Coyote Brown 3740-01-518-7310**

**NSN 3740-01-518-7310- CL 0X item,
must be ordered
through CL IX SARSS**

OD Green (Came) 3740-01-516-4415



The pop-up bed net is factory-treated with permethrin and has much finer mesh than the standard military bed net.

Myth Busters



- No evidence that eating garlic or taking vitamin B tablets reduces mosquito bites
- Dark clothing is usually more attractive than light colored clothing
- Drinking alcohol may increase your attractiveness to mosquitoes



Myth Busters

- Some mosquito control devices use repellents to protect a small outdoor area like a patio
- No products approved by the EPA for indoors
- Effective devices which use **allethrin** or other **pyrethroids** to repel mosquitoes include:
 - Mosquito coils
 - ThermaCell ^(TM) Mosquito Repellent System

Myth Busters



Mosquito magnet can be very effective for area coverage



Myth Busters

- Citronella candles are weak
- Geraniol candles can provide 1 meter of protection



Myth Busters

- Sonic and electronic devices do not work



Final Thoughts

- Vaccine preventable diseases
 - Yellow Fever

Socioeconomic Instability

- Displaced persons/refugees
 - Disaster response
- } 2nd & 3rd Order Effect

References/Resources (1 of 2)

- Guzman, M. and G. Kouri. Dengue haemorrhagic fever integral hypothesis: confirming observations, 1987-2007. Trans. of the Royal Soc. of Trop. Med. Hyg. (2008) 102, 522-523.
- Knowlton, K., Solomon, G. and M. Rotkin-Ellman. Mosquito-Borne Dengue Fever Threat Spreading in the Americas. NRDC Issue Paper. July 2009.
- WRAIR 1367 Project 002. USASOC Dengue Seroprevalence Protocol. 10 Sep 09.
- <http://www.promedmail.org/>
- Evaluation of SD BIOLINE Chagas Ab Rapid kit. Korean J Lab Med. 2009 Feb;29(1):48-52.
- www.gideononline.com
- <http://www.plosntds.org/article/slideshow.action?uri=info:doi/10.1371/journal.pntd.0000196&imageURI=info:doi/10.1371/journal.pntd.0000196.g001> for dengue algorithm.

More Resources (2 of 2)

- ASTMH Intensive Short Course, Annual Pre-Meeting Course and Conference 2009, 2010, 2011. www.astmh.org
- <http://www.cdc.gov/eid/content/14/5/pdfs/814.pdf> for *P. knowlesi* article.
- Field Guide to Medically Important Invertebrates Affecting Military Operations. Jun 2006.
- http://www.afpmb.org/pubs/Field_Guide/field_guide.htm
- Medical Entomology: An Ecological Perspective. G.A.H. McClelland. 12th Edition. 1992.
- An Introduction to the Study of Insects. Borror, Triplehorn, Johnson. 12th Edition.
- Tsetse fly habitat and land cover: an analysis at continental level. <ftp://ftp.fao.org/docrep/fao/010/i0215e/i0215e01.pdf>
- The Social Ecology of Infectious Diseases. Mayer and Pizer. 1st Edition. 2008.

Questions?

COL Jennifer Caci
jennifer.b.caci.mil@mail.mil
(910) 964-9009

